RAPIDLAB® 248
System

Operator's Manual

SIEMENS

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CE

The 248 pH/Blood Gas Analyzer is for In Vitro Diagnostic Use.

Origin: UK

Siemens Healthcare Diagnostics Inc.
Tarrytown, NY 10591-5097 USA

EC REP Siemens Healthcare Diagnostics Ltd.
Sir William Siemens Sq.
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This operator's manual contains complete instructions for setting up and using the 248. Service information for use by appropriately qualified personnel is also available.

The 248 is intended for use by persons knowledgeable in safe laboratory practices. If the 248 is not used in accordance with these instructions for use, the protection provided by the equipment may be impaired.

The information contained in this manual was correct at the time of going to print. However, Siemens Healthcare Diagnostics policy is one of continuous product improvement and the right to change specifications, equipment and maintenance procedures at any time, without notice, is reserved.

Intended Use

The 248 is designed for the fast and accurate determination of pH, pCO_2 and pO_2 in heparinized whole blood samples. The minimum sample volume is 60 µL (capillary). The results are displayed on the alphanumeric display in a choice of units: pH or H^+ nmol/L, and mmHg or kPa for pCO_2 and pO_2.

The 248 also calculates the following parameters:

- standard and actual bicarbonate (HCO_3^-std and HCO_3^-act)
- total carbon dioxide content ($ctCO_2$)
- blood and extra cellular fluid base excess (BE(B) or BE(ecf))
- oxygen saturation (O_2SAT)
- oxygen content (O_2CT)
- arterial-alveolar oxygen tension difference (pO_2(A–a)) and arterial-alveolar oxygen tension ratio (pO_2(a/A)).

WARNING The 248 is designed to be grounded through the power supply lead (line cord) for safe operation. For the safety of operating personnel and optimum performance make sure that the instrument is only connected to a 3-prong socket (outlet) that has an effective earth connection. If you are in any doubt about the safety of your electrical supply system consult a competent, qualified electrician.

There are no user replaceable parts within the instrument. Do not remove the rear cover from the 248.

Siemens Healthcare Diagnostics and its authorized Distributors and Agents consider themselves responsible for the effects of safety, reliability and performance of the 248 only if:

- Assembly operations, extensions, re-adjustments, modifications or repairs are only carried out by persons authorized by them.
- The electrical installation of the relevant room complies with IEC requirements or the local regulatory code.
- The equipment is used in accordance with the instructions for use.

The 248 pH/Blood Gas Analyzer is classed as IEC Type B equipment (Class 1 equipment providing an adequate degree of protection against electric shocks particularly regarding allowable leakage currents and reliability of the protective earth connection).

The 248 is designed for continuous operation and should be connected to the power supply at all times, so that it is always ready for use.

The analyzer complies with IEC 601 for electrical and operating safety. It was not designed for use in an environment containing a flammable anaesthetic mixture with air, oxygen or nitrous oxide and is not designed to give protection against the ingress of liquids.

The 248 is listed by Underwriters Laboratories as meeting the requirements of the following Standards for Safety.

UL 61010A-1 - Electrical Equipment for Laboratory Use; Part 1: General Requirements

CSA C22.2 No. 1010.1 - Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements.

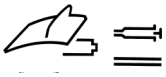
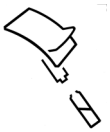
Conventions Used in this Manual

This manual uses the following text and symbol conventions.

Convention	*Description*
Bold	Bold type within text indicates either: 1. A screen name For example, if the word 'Ready' appears as '**Ready**', this indicates that 'Ready' appears on the top left of the screen as the screen name. or 2. A key on the instrument For example, if the number '1' appears as '**1**', it refers to the instrument key marked '1'.
	Caution statements provide information about conditions that may cause product damage.
	Biohazard statements alert you to potentially biohazardous conditions.

Understanding the Symbols

This section describes the symbols that may appear on the exterior of the system or on packaging. The symbols on the system provide you with the location of certain components and with warnings for proper operation. The symbols on the system or packaging provide you with other important information.

Symbol	*Description*
	Shows the probe lever position for sampling from syringes and capillaries
	Shows the probe lever position for sampling from ampules and other open top containers
	Cautions you not to spray this area with cleaning solutions or other fluids that may damage sensitive parts of the system
	Shows the direction of rotation of the pump
	Cautions you about the risk of exposure to potential electrical hazards
	Alerts you to important information about the fuses
	Indicates that the input electricity is alternating current
	Indicates the gas connectors
	Alerts you to important information about gas bottle pressure

Understanding the Symbols

Symbol	Description
	Advises you to consult the instructions for use to obtain safety related information
	Indicates that the analyzer is classed as IEC Type B equipment (Class 1 equipment providing an adequate degree of protection against electric shocks particularly regarding allowable leakage currents and reliability of the protective earth connection)
	Indicates that the system is listed by Underwriters Laboratories as meeting U.S. and Canadian requirements for safety
	Indicates that the system meets the requirements of the European Union
	Indicates an *in vitro* diagnostic medical device
	Manufacturer
	Date of manufacture
	Authorized Representative
	Shows the manufacturer of the serial plate (Donprint)
	Catalog Number
	Cautions you about the risk of exposure to biohazards
	Advises you to consult the operating instructions to obtain information needed for the proper use of the instrument
	Shows the area in which the date can be written in pencil
	Fragile, handle with care
	Temperature limitation (4˚ - 25˚C)
	Harmful
	Keep dry
	Keep away from sunlight and heat
	Sterile

Understanding the Symbols

Symbol	Description
	Batch code
SN	Serial Number
	Use by
	Control
	Indicates maximum fill level
	Do not re-use
	Do not stack
	Do not use if package is damaged
	Keep this way up
	Please recycle this packaging
	Printed on recycled materials
	Indicates compliance with Green Dot packaging standards
	Indicates compliance with RESY packaging standards
	This system contains certain toxic or hazardous substances or elements. The environmental protection use period for this system is 50 years. The system can be used safely during its environmental protection use period. The system should be recycled immediately after its environmental protection use period has expired.

Contents

Contents

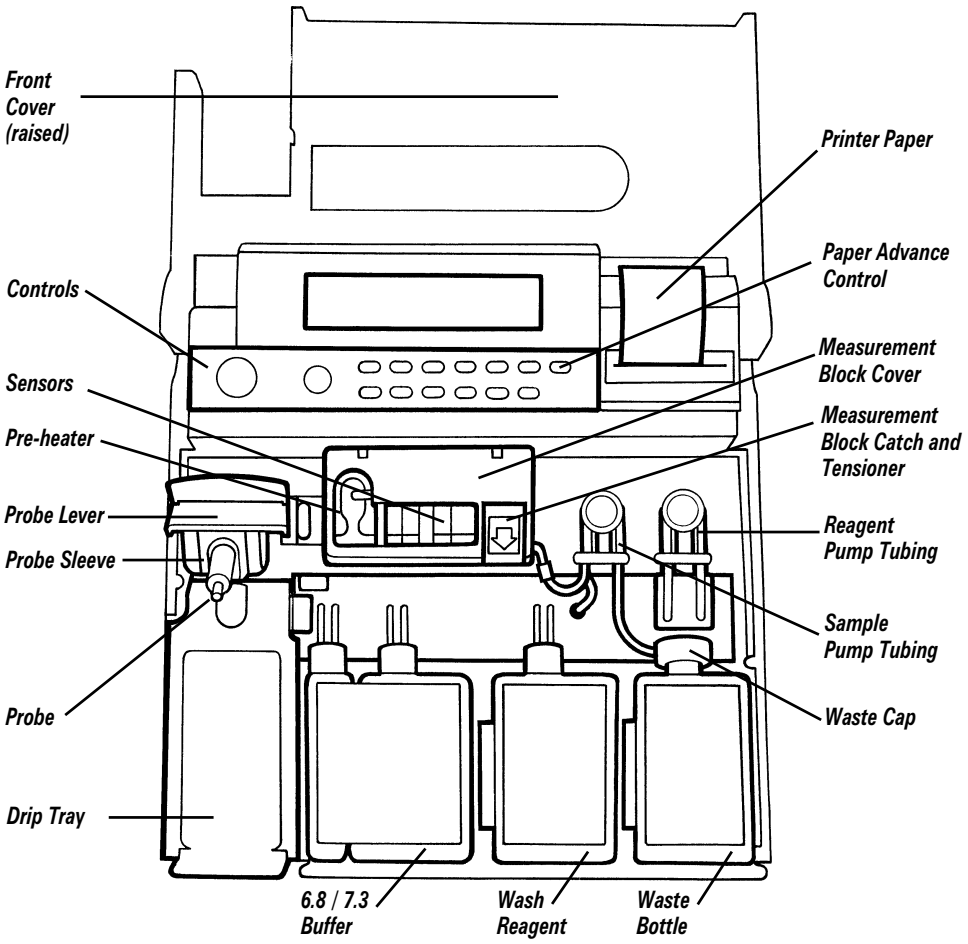
Contents

Contents

1 Understanding the System

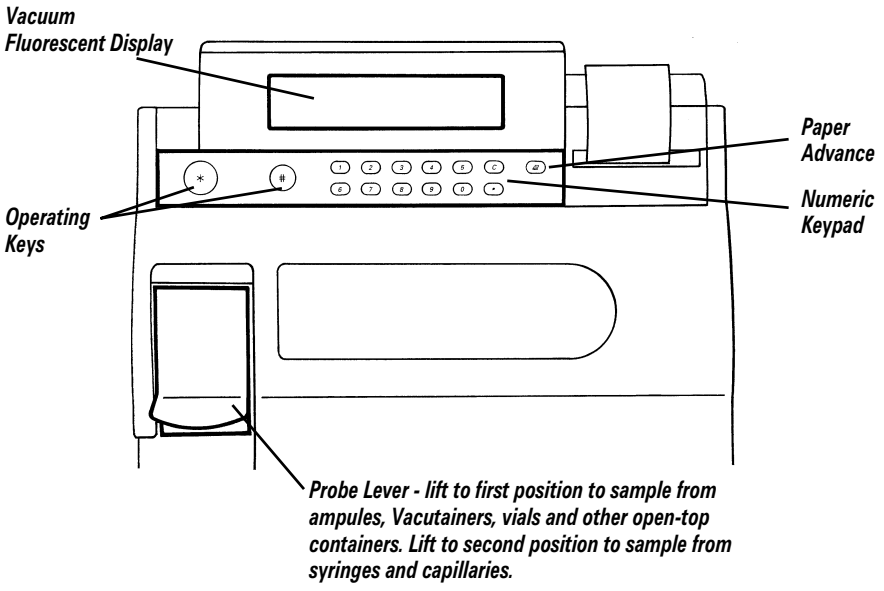
248 pH/Blood Gas Analyzer Overview

Figure 1-1. Overview of 248 Analyzer



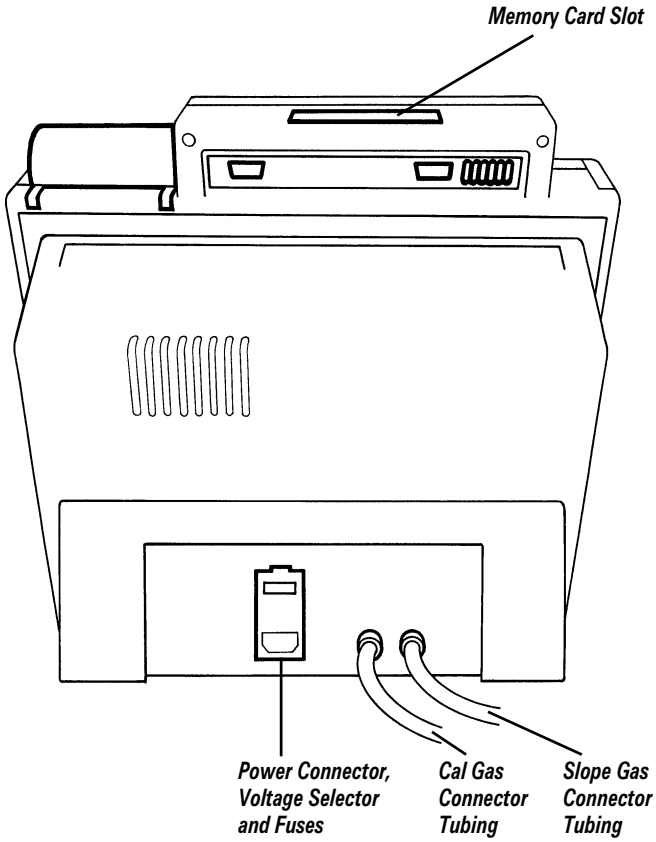
The Front Panel

Figure 1-2. The Front Panel



The Rear Panel

Figure 1-3. The Rear Panel



These symbols appear on the rear of the instrument.

Symbol	*Description*
Port 1	Data Port 1, 9-way D-line
Port 2	Data Port 2, 9-way D-line
Status Indicators	Status Indicators
~	Indicates that the input electricity is alternating current
DP	Shows the manufacturer of the serial plate (Donprint)
IVD	Indicates an *in vitro* diagnostic device
	Manufacturer
	Cautions you about the risk of exposure to potential electrical hazards
	Advises you to consult the instructions for use to obtain safety related information.

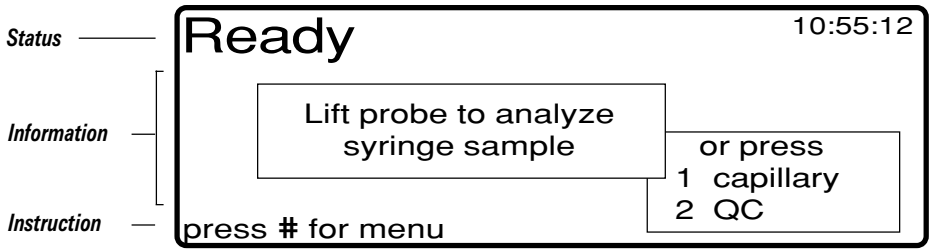
The Rear Panel

Symbol	Description
EC REP	Authorized Representative
SN	Serial Number
	Alerts you to important information about the fuses
	Indicates that the system is listed by Underwriters Laboratories as meeting U.S. and Canadian requirements for safety
	Indicates that the system meets the requirements of the European Union
	Indicates that the analyzer is classed as IEC Type B equipment (Class 1 equipment providing an adequate degree of protection against electric shocks particularly regarding allowable leakage currents and reliability of the protective earth connection)
	Indicates the gas connectors

The 248 Software

The 248 is very easy to use, and the display leads you through the necessary steps to analyze samples, or to use any of the other functions.

The 248 will normally display the **Ready** screen. (Full details of how to measure samples are in Section 2, *Operating the System*.)



The display is divided into 3 parts:

- status. The top line shows the status of the 248. On this screen the status line shows that the 248 is ready to analyze a sample.
- information. This area gives more detailed information, lists options and selections, and gives fields for data entry.
- instruction. This line gives instructions, or alternative action.

∗ key - starts sampling process during capillary sample measurement. Exits procedures where exit is possible. Returns display to previous screen when moving round menu, setting options and so on.

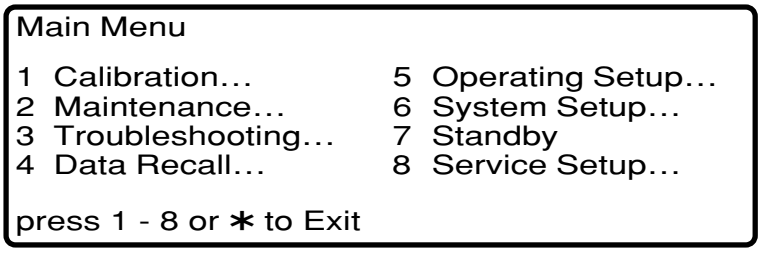
key - selects alternative action where one is displayed. Moves round data entry screens.

Choosing Options

The bottom (instruction line) of the **Ready** screen says press # for menu.

From **Ready** press #

The **Main Menu** has 8 sub menus:



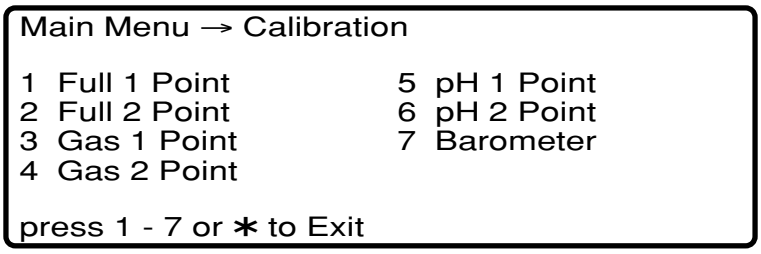
The status line shows where you are (Main Menu), the information area lists the sub menus, and the instruction line tells you how to select your option and gives an alternative action (press ∗ to Exit).

You can select any of the sub menus by pressing the corresponding number on the numeric keypad (to return to the **Ready** screen press ∗).

Press **1**.

Choosing Options

The selected menu (Calibration) is highlighted briefly, confirming the keypress. The display shows the **Calibration** menu.



As before, the status line shows where you are (Main Menu - Calibration), the information area lists the options available in the calibration menu, and the instruction line tells you how to select your option and gives an alternative action (press ∗ to Exit).

To return to the **Ready** screen from anywhere in the menus, press ∗ to backstep through the screens.

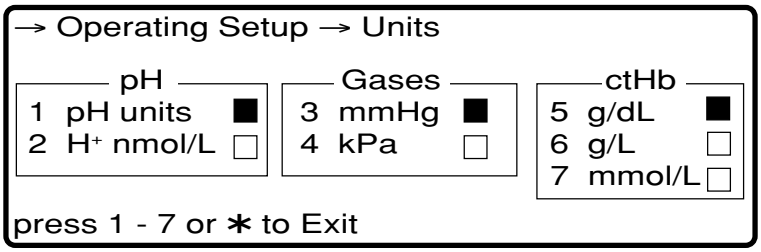
From **Main Menu** → **Calibration** press ∗. The 248 returns to the **Main Menu** screen. Press ∗ again, the 248 returns to the **Ready** screen.

Check Boxes

Some options are shown as check boxes. These options are also selected by pressing the corresponding number on the keypad.

To see an example of check boxes:

From **Ready** press **#** for **menu**; **5** to select **Operating Setup** and **3** to select **Units**.



■ means that the option is selected,

□ means that the option is not selected.

Press the corresponding number on the keypad to select alternative options.

Press ∗ 3 times to backstep through the menu screens to the **Ready** screen.

The main points to remember are:

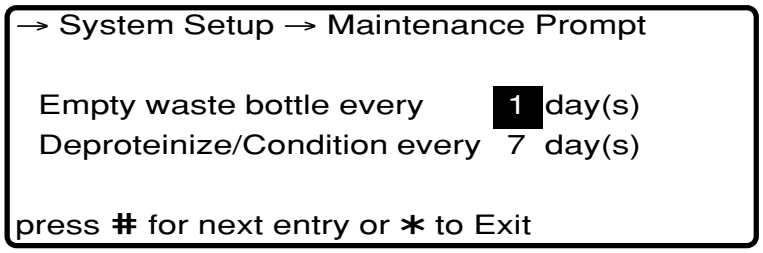
- You choose an option from the list displayed by pressing the corresponding number on the keypad.
- You can return to the **Ready** screen by pressing ∗ to backstep through the screens.

Entering Data

If you choose an option where you can enter data, the area (or field) for the data is highlighted.

To see an example of data entry fields:

From **Ready** press **#** for **menu**, **6** to select **System Setup** and **2** to select **Maintenance Prompt**.



The **Empty waste bottle** field is highlighted. Use the numeric keypad to enter a number here.

To confirm the number and move to the next field press **#**.

To confirm the number and exit the screen press *****.

You can also use **#** to move around the fields in a data entry screen without changing any numbers already entered. So, if you do not want to change the number of days for the waste bottle prompt press **#** to move to the next field. The Deproteinize/Condition field is then highlighted.

Press ***** 3 times to backstep through the menu screens to the **Ready** screen.

The main points to remember are:

- You cannot enter or change a number unless its field is highlighted.
- A number is not entered until confirmed by pressing **#** or *****. Press **#** to confirm and move to the next field, or ***** to confirm and exit the screen.
- You can move around the fields in a data entry screen using **#**. Any numbers already entered in these fields will not be changed.
- You can return to the **Ready** screen by pressing ***** to backstep through the screens.
- You can enter a negative number (for correlation intercept only) by pressing the **C** key when the entry field is empty (blank). Press the **C** key again to cancel the minus sign.

Setup Options

You can configure the 248 by choosing units of measurement, setting reference ranges and so on. This is covered in Section 5, *Configuring the System*. Section 5 also gives recommended settings where applicable.

You can, of course, use the 248 using the default (factory set) options and values. These are given below.

Operating Setup

QC

pH	6.001 - 8.000	(10.0 - 997.7 nmol/L H^+)
pCO_2	5.0 - 250.0 mmHg	(0.67 - 33.33 kPa)
pO_2	0.00 - 749.0 mmHg	(0.00 - 99.86 kPa)

Reference Ranges

pH	7.350 - 7.450	(35.5 - 44.7 H^+ nmol/L)
pCO_2	35.0 - 45.0 mmHg	(4.67 - 6.00 kPa)
pO_2	80.0 - 100.0 mmHg	(10.67 - 13.33 kPa)

Units

pH	pH units
Gases	mmHg
*c*tHb	g/dL

Calibration

method and interval		flexible time, 30 minutes
gas values		
	cal	5% CO_2 12% O_2
	slope	10% CO_2 0% O_2

Printer Options

printer	on
print	results only

Correlation

pH slope	1.000
pH intercept	0.000
pCO_2 slope	1.000
pCO_2 intercept	0.000
pO_2 slope	1.000
pO_2 intercept	0.000

CAUTION: These values must not be changed without first referring to Section 5, *Configuring the System*.

System Setup

Date/Time

set

Maintenance Prompt

empty waste	every day
deproteinize/condition	every 7 days

Parameters

measured	pH, pCO_2 and pO_2 selected
calculated	none selected

Beeper

beeper	on

Communications

Port 1 CMSI
Port 2 CMSI

Security

menu password	not set

Service Setup

System Information

serial number	set
service number	not set

Language Selection

English

Sample Information

Blood sample procurement must be carried out under proper medical supervision, including site selection, specific procedures utilized, and sample handling documentation. Sterile technique is required at all times to avoid infection of the puncture site. The specific details of any collection must be approved by the medical person responsible.

CAUTION: Interpret results from patients anesthetized with halothane or nitrous oxide with care as the pO_2 values may be unreliable.

BIOHAZARD: All samples must be treated with the caution accorded to those known to contain pathogenic organisms.

Sample Types

Arterial blood has been widely recommended for use in blood gas studies because it accurately reflects acid-base physiology and oxygenation status. Routinely, arterial blood may be obtained from the radial, femoral or brachial arteries. Other sites may be used following catheterization or surgical procedures.

Venous blood can provide satisfactory pH and pCO_2 values; however, venous pO_2 samples may not be significant in routine clinical study without simultaneous study of arterial pO_2.

Venous samples can be obtained using vacuum tube collection systems, from an anticubital vein. Other sites may be used as necessary. Reported venous oxygen saturation values must be labelled as such to allow the correct interpretation of the results.

Capillary blood, when carefully collected under the proper conditions closely resembles arterial blood and may be used for blood gas studies. Capillary analysis has the advantage that only small quantities of blood are necessary for measurement. Capillary blood may be obtained from the heel, finger or earlobe. The chosen area should be prewarmed or otherwise stimulated to promote arterial circulation before the puncture. The puncture should be deep enough to make sure that the blood flow is free and rapid.

Syringes

Blood samples collected in Siemens Healthcare Diagnostics heparinized syringes or equivalent are satisfactory for use with the 248. The syringe must be filled completely as incomplete filling will raise the level of heparin in respect to the sample. Room air contamination, a concern in pO_2 determinations, can be minimized by avoiding drawing air into the sample. Immediately after drawing the sample, expel all air from the syringe, cap securely and thoroughly mix the sample.

Capillary Tubes

Capillary blood should be collected using Siemens capillary tubes. The minimum sample volume from a capillary is 60 µL. The capillary tube should be completely filled and the ends securely capped. The samples must be mixed thoroughly.

CAUTION: If you use a mixing flea, remove the flea prior to sampling to prevent damaging the 248.

Vacuum Tube Collection Systems

Vacuum tube systems containing lithium heparin can be used for venous samples. Make sure the tube is filled completely, and the samples are well mixed by gentle inversion.

Sample Handling

Significant errors in measurements on properly collected whole blood samples may be caused by:

- metabolic changes in the sample occurring between sampling and analysis,
- contamination of the sample by room air,
- improper mixing of the sample before measurement.

Minimize errors due to metabolic changes by analyzing samples as soon as possible after collection. This is particularly important for pO_2 samples, as oxygen is consumed during storage.

The rate of oxygen consumption is dependant on several factors; the initial pO_2, the storage temperature, the white blood cell count, and the reticulocyte count.

If samples will not be analyzed within ten minutes of collection, place them in iced water. Samples stored in this manner may be kept for up to 2 hours without significant change in values. Samples with high white blood cell counts or high reticulocyte counts deteriorate more rapidly, and should be analyzed immediately.

Improper mixing of samples before analysis may give erroneous results. Blood cells settle during storage, and if not well mixed before sampling, the results obtained can be higher or lower than the actual values. Syringes should be rolled between the hands, and gently inverted several times. Vacuum tubes should be gently inverted until the sample is homogenous. Capillary samples must be thoroughly mixed by rolling until homogenous. Clot formation may cause sample pathway blockages.

Reagents

WARNING Wear safety glasses, gloves and a laboratory coat when handling the reagents.

The reagents described in this section are for in vitro diagnostic use only. Siemens cannot guarantee the performance of the system in any of the following situations:

- Reagents other than those recommended are used.
- Expiry dates of reagents have been exceeded.
- Reagent 'change by' date has been exceeded.
- Reagents are not used or stored according to Siemens recommendations.
- Standard laboratory practices are not followed.
- The procedures in this manual are not followed.

Active Ingredients

Material Safety Data Sheets for the 248 reagents are supplied by your local distributor.

Intended Use

7.382 buffer	provides the calibration point for 1 and 2 point pH calibrations. 7.382 buffer is buffered to a pH of 7.382 at 37°C and is NIST traceable.
6.838 buffer	provides the slope point for 2 point pH calibrations. 6.838 buffer is buffered to a pH of 6.838 at 37°C and is NIST traceable.
Wash	washes the probe and sample path.
Deproteinizer	removes protein buildup from the sample path. It is used regularly as preventative maintenance for the 248.
Conditioner	cleans and conditions the pH sensor. It is used regularly as preventative maintenance for the 248.

Storage

Store all reagents away from direct sunlight at 4 - 25°C.

Discard 7.382 and 6.838 buffers 30 days after opening.

Do not use reagents after the expiry date.

Discard Deproteinizer and Conditioner solution after single use.

Handling and Preparation

7.382 buffer, 6.838 buffer, Wash and Conditioner require no preparation before use.

Prepare Deproteinizer as directed by the instructions on the package.

Waste Disposal

BIOHAZARD: See Appendix A, *Protecting Yourself From Biohazards*.

Refer to Page 3-4, *Emptying the Waste Bottle*, for detailed instructions on handling the waste bottle.

Discard the waste bottle and its contents according to your laboratory protocol. NCCLS Publication GP5 gives detailed guidelines.[25]

Calibration Gases

Two gas standards are used to calibrate the pCO_2 and pO_2 sensors.

Cal Gas — provides the calibration point for 1 and 2 point pCO_2 and pO_2 calibrations. Cal Gas contains 5.00 ± 0.05% carbon dioxide and 12.00 ± 0.05% oxygen, balanced with nitrogen and is NBS traceable.

Slope Gas — provides the slope point for 2 point pCO_2 and pO_2 calibrations. Slope Gas contains 10.00 ± 0.05% carbon dioxide balanced with nitrogen and is NBS traceable.

WARNING Compressed gas cylinders require careful handling. To prevent damage and possible personal injury, observe the following precautions:

- Never drop cylinders, allow them to strike each other or subject them to other strong shocks.
- Secure cylinders to a wall or bench, or place in a cylinder base support stand.
- Never drag, roll or slide cylinders, even for short distances. Use a suitable hand truck to move cylinders.
- Never tamper with safety devices in regulators or cylinders.
- Use these gases for the calibration of clinical and research instrumentation only. US Law prohibits dispensing these gases for drug use.
- The contents are under pressure – do not puncture.
- Do not use or store near heat or open flame.
- Do not expose cylinders to temperatures above 54°C (130°F) as this may cause the contents to vent or explode.
- Never throw cylinders into fire or incinerators. Follow the disposal instructions on the cylinders.

Calibration

The 248 automatically calibrates using one of the following user-selectable methods. Five minutes before a calibration is due a countdown message appears on the **Ready** screen. Samples can still be measured during this time.

Fixed Time

The 248 automatically calibrates at a specified time interval. The interval is user-selectable, and can be 30 or 60 minutes. A 1 point calibration is carried out at every interval. A full 2 point calibration is carried out at every fourth interval.

For example:

When the interval is set to 30 minutes, the 248 automatically carries out a 1 point calibration every 30 minutes, and a 2 point calibration every 2 hours.

Calibration

Flexible Time

The 248 automatically calibrates as required and calculates the time between calibrations to optimize performance. The maximum time interval between calibrations is user-selectable and can be 30 or 60 minutes. The time between 1 point calibrations will be between 10 minutes and the maximum time interval selected. A full 2 point calibration is carried out at every fourth interval.

For example:

When the interval is set to 30 minutes, the 248 automatically carries out a 1 point calibration at least once every 30 minutes and a 2 point calibration at least every 2 hours.

General

In both fixed and flexible time methods, the 248 automatically calibrates after certain maintenance routines, for example, the **Disinfect**, **Deproteinize** and **Condition** routines. It also calibrates if a sampling fault occurs, for example 'Sample not detected'.

QC

Siemens recommends that a Quality Control program is set up to monitor instrument and operator performance. Because the needs of each laboratory are different, due to size of workload, number of hours worked, statutory regulations and so on, no attempt has been made to formulate a rigid program. Users should follow local regulatory guidelines to establish a QC program.

Use only Siemens approved QC materials. If you report your results to a quality control statistical program, make sure they are informed of the analyzer - Siemens 248 pH/Blood Gas Analyzer.

QC Handling

Significant errors in QC measurements may be caused by:

- improper storage and temperature equilibration of the QC sample,
- improper mixing of the QC sample,
- contamination of the QC sample by room air.

Always follow the manufacturer's instructions for use carefully, especially regarding the temperature of the QC before sampling. Mix the ampule thoroughly, and once opened sample the QC immediately. Do not re-use an opened ampule. Position the probe near the bottom of the ampule to obtain a representative sample.

See references 1 - 4 for further information on Quality Control.

2 Operating the System

Ready Screen

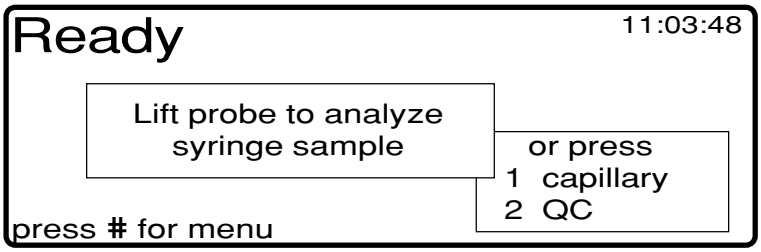
The **Ready** screen shows either syringe, capillary or QC in the main message, depending on the last sample measured. If you want to measure a different type of sample press **1** or **2** to select the appropriate sample type.

For example, from the following screen:

to measure a syringe sample lift the probe

to measure a capillary sample press **1**

to measure a QC sample press **2**



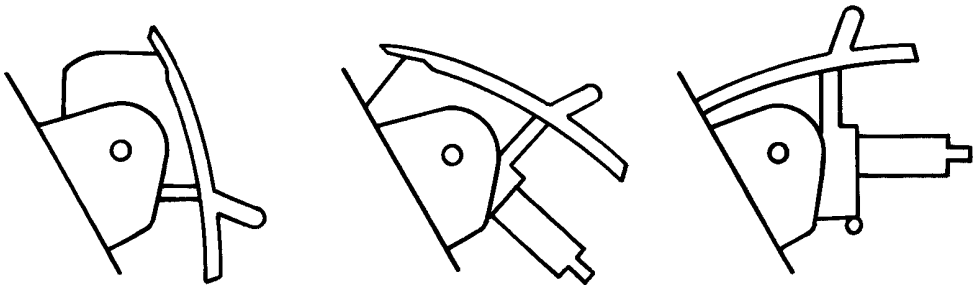
Probe Lever Position

There are two probe lever positions for sampling. For ease of use and optimum performance it is important that you use the correct position for your sampling device.

The first position is for sampling from ampules and other open top containers. In this position the probe is deeper in the solution, enabling a more representative sample to be taken.

The second position is for sampling from syringes and capillaries. In this position the probe will not protrude as far, lessening the possibility of it touching the syringe plunger.

Figure 2-1. Probe Lever Positions



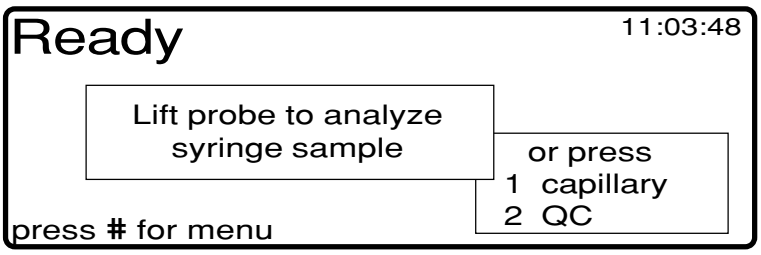
Closed ***First Position Ampules*** ***Second Position Syringes/Capillaries***

If you use a different position to the one recommended the 248 displays a 'confirm sample type' message.

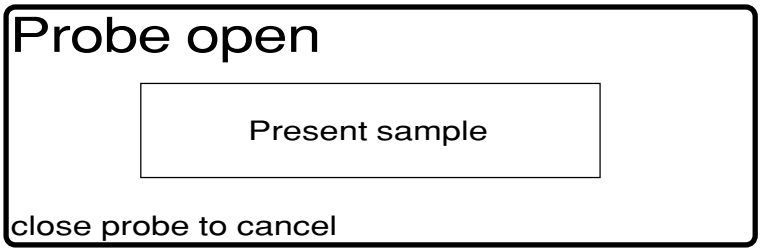
Analyzing Syringe Samples

BIOHAZARD: See Appendix A, *Protecting Yourself From Biohazards*.

1. If the main message shows capillary or QC sample press **1** to select syringe.



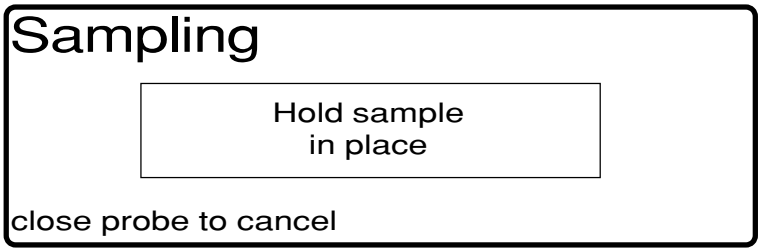
2. Lift the probe lever to the second position.



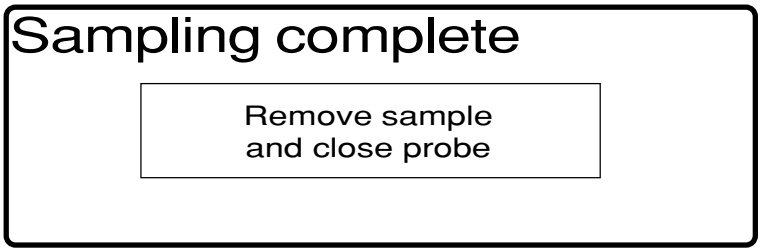
3. Slide the syringe sample onto the probe and gently push the probe sleeve back. The 248 beeps when the probe sleeve is in the correct position and starts sampling.

CAUTION: Try to position the probe to obtain the most representative sample – do not allow the probe tip to touch the syringe plunger.

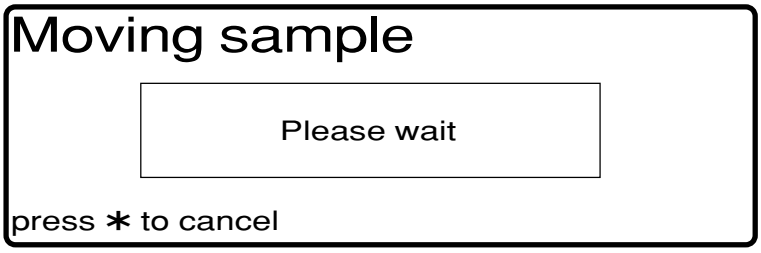
NOTE: If you have a very small syringe sample, present the sample and press ∗, then confirm syringe sample when prompted.



4. Hold the sample in place. The 248 beeps when sampling is complete.

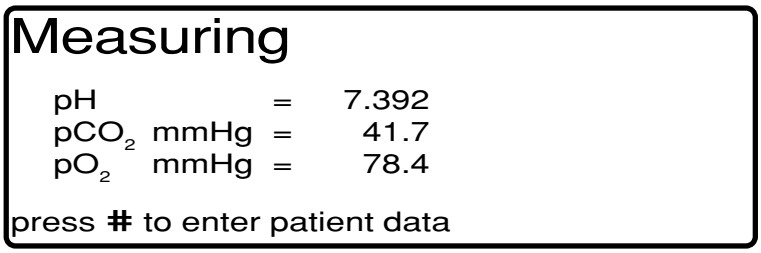


5. Remove the sample and close the probe.

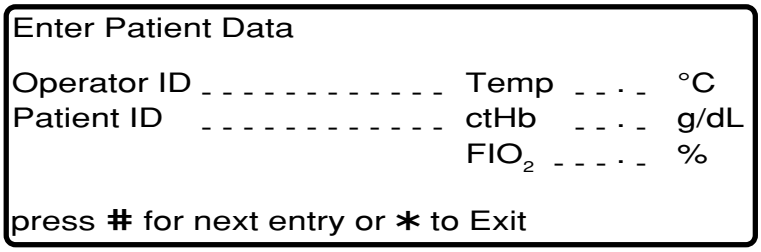


Analyzing Syringe Samples

If a bubble or short sample is detected the 248 will alert you. See Page 2-8 for detalis.



6. Press # if you want to enter patient data.



You can enter up to 12 digits for operator and patient ID. You can use the decimal point key to insert dashes.

The other values that can be entered are:

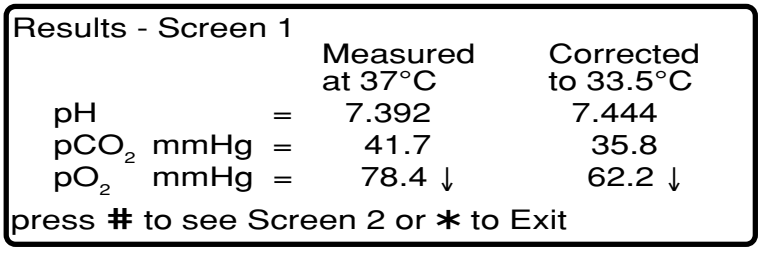
- patient temperature 10.0 - 43.9°C
- *c*tHb 2.0 - 25.0 g/dL (20 - 250 g/L or 1.2 - 15.5 mmol/L)
- F_IO_2 15.0 - 100.0%.

The 248 will use the values entered for patient temperature, *c*tHb and F_IO_2 when calculating the results. If you do not enter patient data the 248 uses normal (default) temperature (37°C), *c*tHb (15 g/dL (150 g/L, 9.6 mmol/L)) and F_IO_2 (20.9%) values in the calculations, with the following exceptions:

- O_2CT will not be reported unless *c*tHb is entered, and
- pO_2(A-a) and pO_2(a/A) will not be reported unless F_IO_2 is entered.

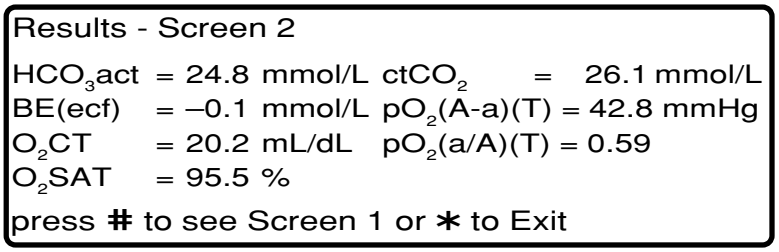
Results may also be corrected for patient temperature, *c*tHb and F_IO_2 after measurement - see *Recalling Last Sample Data*, Page 2-10.

Example result. If the measured values are outside the reference ranges an arrow indicates if they are above or below the range. If you selected calculated parameters they are displayed on Screen 2. (See Section 5, *Configuring the System,* for details on reference ranges and calculated parameters.)



Analyzing Syringe Samples

7. Press # if you want to see the calculated parameters. Up to 8 parameters are shown on screen 2; all the parameters selected will be printed.



Example Printout

```
Blood Gas Report
248-9265   10:56  Apr 11 1994
Sample No.  5060      Syringe
Operator ID 46
Patient  ID 9012

Corrected 33.5°C
  pH      7.444
  pCO2     35.8       mmHg
  pO2      62.2  ↓    mmHg
  ↑,↓= outside ref. range

 Measured    37°C
  pH      7.392
  pCO2     41.7       mmHg
  pO2      78.4  ↓    mmHg
  ↑,↓ =  outside ref. range

 Reference Ranges
  pH    7.350  -  7.450
  pCO2   35.0  -   45.0
  pO2    80.0  -  100.0

Calculated Data
  HCO3act      24.8  mmol/L
  BE(ecf)      -0.1  mmol/L
  O2CT         20.2  mL/dL
  O2SAT        95.5  %
  ctCO2        26.1  mmol/L
  pO2(A-a)(T)  42.8  mmHg
  pO2(a/A)(T)  0.59

Entered Data
  Temp         33.5  °C
  ctHb         15.0  g/dL
  FIO2         20.9  %

---------------
```

Instrument ID, time and date, operator and patient ID, and sample type and number

Corrected values

Measured values

Reference ranges

Calculated parameters

Patient temperature, *c*tHb and F_IO_2

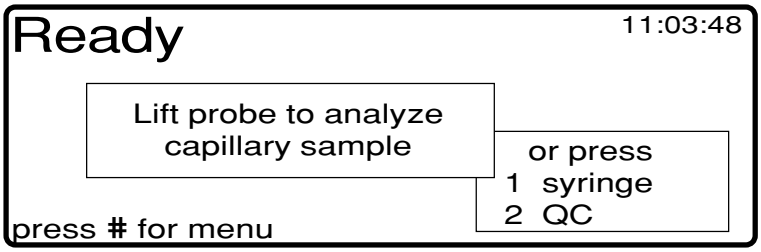
While the results are displayed and printed, the 248 washes the probe and sample path. When the wash has finished you can press * to return to the **Ready** screen.

Analyzing Capillary Samples

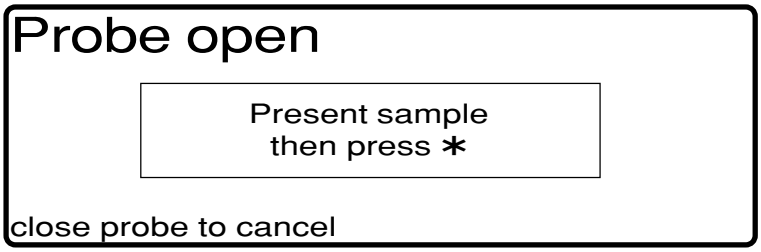
BIOHAZARD: See Appendix A, *Protecting Yourself From Biohazards*.

The minimum sample volume for a capillary sample is 60 µL.

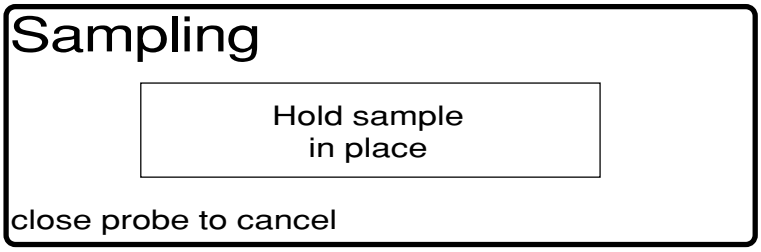
1. If the main message shows syringe sample press **1** to select capillary, if the main message shows QC sample press **2** to select capillary.



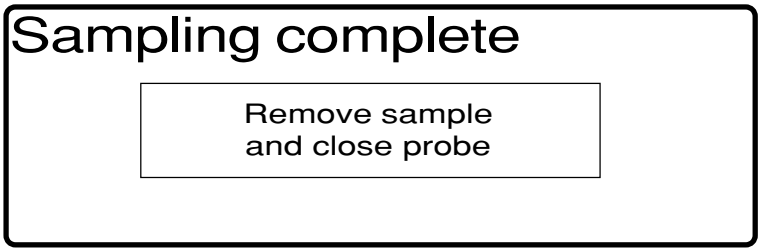
2. Lift the probe lever to the second position.



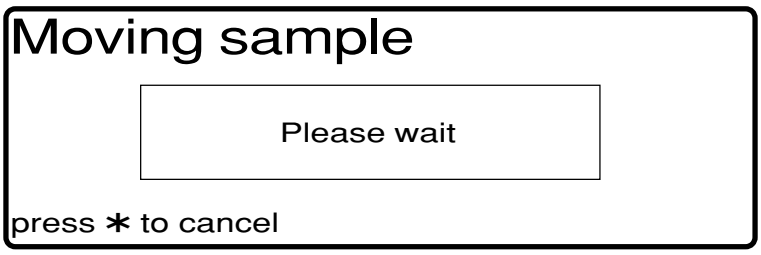
3. Remove the caps from the end of the capillary and carefully fit a capillary adaptor. Slide the adaptor onto the probe, then press *. The 248 beeps when you press *.



4. Hold the capillary in place. The 248 beeps when sampling is complete.

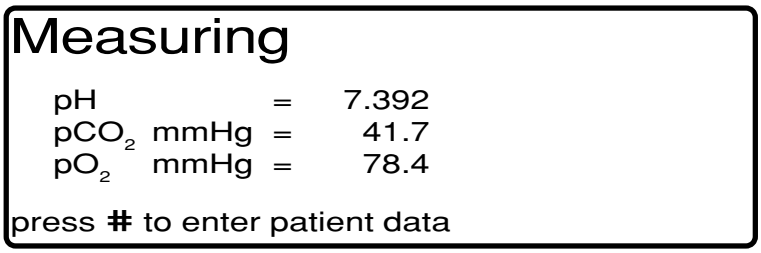


5. Remove the capillary and adaptor and close the probe.

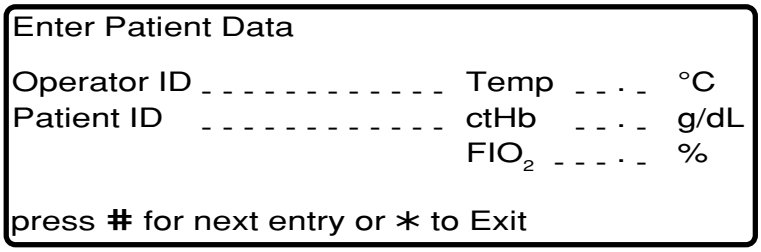


Analyzing Capillary Samples

If a bubble or short sample is detected the 248 will alert you. See page 2-8 for details.



6. Press # if you want to enter patient data.



You can enter up to 12 digits for operator and patient ID. You can use the decimal point key to insert dashes.

The other values that can be entered are:

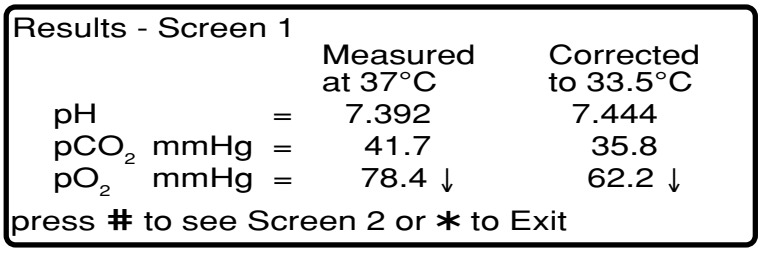
- patient temperature 10.0 - 43.9°C
- *c*tHb 2.0 - 25.0 g/dL (20 - 250 g/L or 1.2 - 15.5 mmol/L)
- F_IO_2 15.0 - 100.0%.

The 248 will use the values entered for patient temperature, *c*tHb and F_IO_2 when calculating the results. If you do not enter patient data the 248 uses normal (default) temperature (37°C), *c*tHb (15 g/dL (150 g/L, 9.6 mmol/L)) and F_IO_2 (20.9%) values in the calculations, with the following exceptions:

- O_2CT will not be reported unless *c*tHb is entered, and
- pO_2(A-a) and pO_2(a/A) will not be reported unless F_IO_2 is entered.

Results may also be corrected for patient temperature, *c*tHb and F_IO_2 after measurement - see *Recalling Last Sample Data*, Page 2-10.

Example result. If the measured values are outside the reference ranges an arrow indicates if they are above or below the range. If you selected calculated parameters they are displayed on Screen 2. (See Section 5, *Configuring the System,* for details on reference ranges and calculated parameters.)



Analyzing Capillary Samples

7. Press **#** if you want to see the calculated parameters. Up to 8 parameters are shown on screen 2; all the parameters selected will be printed.

Results - Screen 2			
HCO_3act	= 24.8 mmol/L	$ctCO_2$	= 26.1 mmol/L
BE(ecf)	= –0.1 mmol/L	pO_2(A-a)(T)	= 42.8 mmHg
O_2CT	= 20.2 mL/dL	pO_2(a/A)(T)	= 0.59
O_2SAT	= 95.5 %		
press # to see Screen 1 or * to Exit			

Example Printout

Blood Gas Report

```
248-9265   10:59  Apr 11 1994
Sample No.  5061    Capillary
Operator ID 46
Patient  ID 9012
```

Instrument ID, time and date, operator and patient ID, and sample type and number

Corrected 33.5°C

```
  pH      7.444
  pCO2     35.8       mmHg
  pO2      62.2  ↓    mmHg
  ↑,↓= outside ref. range
```

Corrected values

Measured 37°C

```
  pH      7.392
  pCO2     41.7       mmHg
  pO2      78.4  ↓    mmHg
  ↑,↓ =  outside ref. range
```

Measured values

Reference Ranges

```
  pH    7.350  -  7.450
  pCO2   35.0  -   45.0
  pO2    80.0  -  100.0
```

Reference ranges

Calculated Data

```
  HCO3act      24.8  mmol/L
  BE(ecf)      -0.1  mmol/L
  O2CT         20.2  mL/dL
  O2SAT        95.5  %
  ctCO2        26.1  mmol/L
  pO2(A-a)(T)  42.8  mmHg
  pO2(a/A)(T)  0.59
```

Calculated parameters

Entered Data

```
  Temp         33.5  °C
  ctHb         15.0  g/dL
  FIO2         20.9  %
```

Patient temperature, *c*tHb and F_IO_2

```
----------------
```

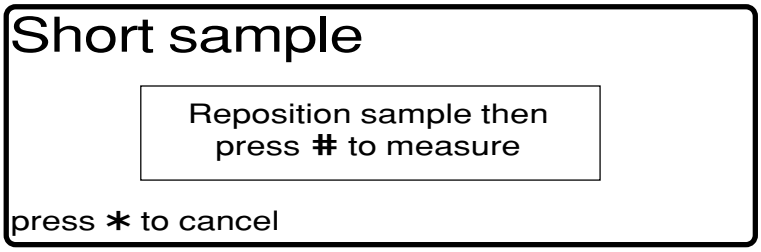
While the results are displayed and printed, the 248 washes the probe and sample path. When the wash has finished you can press * to return to the **Ready** screen.

Measuring a Short Sample or a Sample with a Bubble

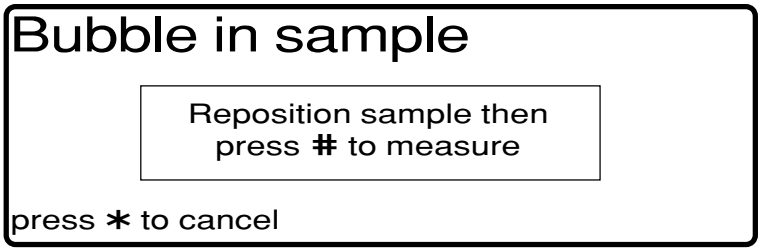
The 248 detects short samples or bubbles in samples and gives you 2 options:

- reposition the sample so there are no air bubbles under the sensors and then continue with the analysis, or
- flush the sample out of the measurement block ready to repeat the analysis.

The 248 beeps and displays:



OR

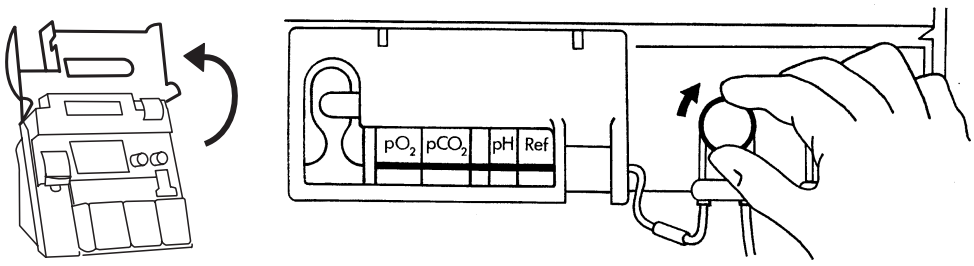


This message is displayed for 1 minute. If no action is taken the 248 flushes the sample out of the measurement block.

Continuing with the Sample Analysis

1. If you want to measure the sample lift the front cover and look at the measurement block.
2. Turn the sample pump rotor (the sample pump is the lefthand pump) in the direction indicated, so that the sample is repositioned directly beneath the sensors for which results are required.

Figure 2-2. Repositioning Samples



CAUTION: Do not move samples backwards as KCl from the reference sensor may contaminate the other sensors.

Measuring a Short Sample or a Sample with a Bubble

⚠ **CAUTION:** Special care must be taken to make sure that the sample is repositioned directly beneath the sensors for which results are required. For example, for pO_2 and pCO_2 results, the sample must be positioned under the pO_2 and pCO_2 sensors with no air bubbles present. For pH results the sample must be positioned under the pH and reference sensors with no air bubbles present. Air bubbles present under one of the sensors as a result of incorrect sample repositioning may lead to erroneous results.

3. When you are satisfied that the sample is correctly repositioned press **#**. The sample analysis continues. The printout shows 'Short sample' or 'Bubble in sample'.

Cancelling the Sample Analysis

1. If you have enough sample left to repeat the analysis, press **∗**.
2. The sample is flushed out of the measurement block and the display returns to the **Ready** screen.

Requesting an Additional Calibration

The 248 automatically calibrates using one of the user-selectable methods (see Section 1, *Understanding the System*, for details).

The Calibration menu allows additional, user-requested calibrations to be carried out.

1. From **Ready** press **#** for **menu**, and **1** for **Calibration**.

```
Main Menu → Calibration

1  Full 1 Point          5  pH 1 Point
2  Full 2 Point          6  pH 2 Point
3  Gas 1 Point           7  Barometer
4  Gas 2 Point

press 1 - 7 or ∗ to Exit
```

2. Press **1** - **6** to select the type of calibration you want.

   The 248 displays each stage of the calibration on the status line.

   The calibration results are displayed and the 248 confirms when the calibration is successful.

   A successful, user-requested calibration resets the automatic calibration timer.

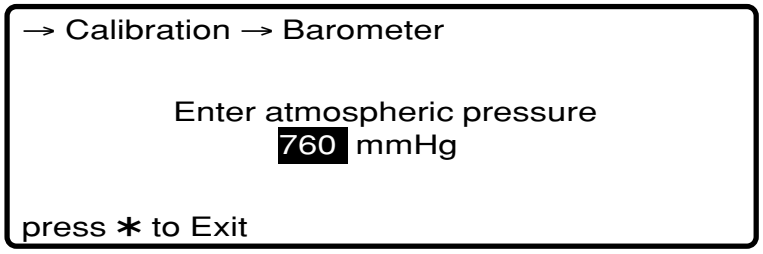
   The 248 will not allow a partial calibration if a full calibration is due. For example, if you press **1** when a 2 point calibration is due, the 248 displays 'Full 2 point required'.

Calibrating the Barometer

The Calibration menu also allows you to check the atmospheric pressure and to recalibrate the internal barometer.

1. From **Ready** press **#** for **menu**, **1** for **Calibration** and **7** for **Barometer**.

Calibrating the Barometer



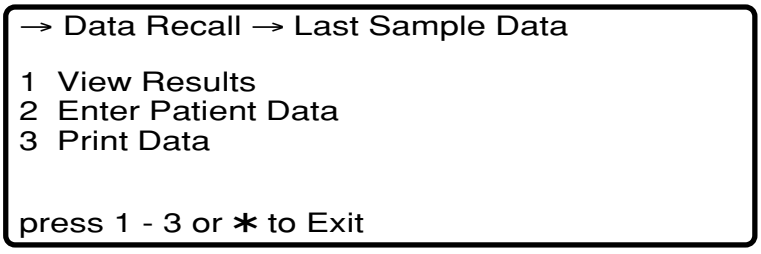
The adjustment range for the barometer is the displayed value ± 20 mmHg.

Recalling Last Sample Data

The 248 retains the data for the last sample measured. The Data Recall menu allows:

- data to be recalled,
- patient data to be entered or changed,
- results to be printed.

1. From **Ready** press **#** for **menu**, **4** for **Data Recall** and **1** for **Last Sample Data**.



2. Press **1** to recall the results Screen 1 to the display. (The calculated parameters are also recalled, press **#** to see Screen 2.)

3. Press **2** if you want to enter or change the patient data. You can enter patient and operator ID, and patient temperature, *c*tHb and F_IO_2.

   You can enter up to 12 digits for operator and patient ID. You can use the decimal point to insert dashes.

   The other values that can be entered are:

   - patient temperature 10.0 - 43.9°C
   - *c*tHb 2.0 - 25.0 g/dL (20 - 250 g/L or 1.2 - 15.5 mmol/L)
   - F_IO_2 15.0 - 100.0%.

   The 248 will use these values for recalculating the results. If you do not enter patient data the 248 uses the values entered previously, or if none were entered normal (default) temperature (37°C), *c*tHb (15 g/dL (150 g/L, 9.6 mmol/L)) and F_IO_2 (20.9%) are used, with the following exceptions:

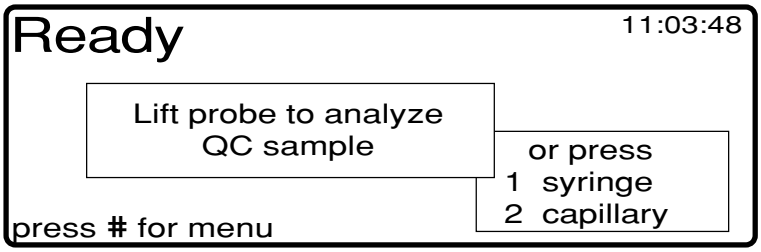
   - O_2CT will not be reported unless *c*tHb is entered, and
   - pO_2(A-a) and pO_2(a/A) will not be reported unless F_IO_2 is entered.

4. Press **3** if you want to print the data. The printout shows the date and time the sample was analyzed, not the time of recall.

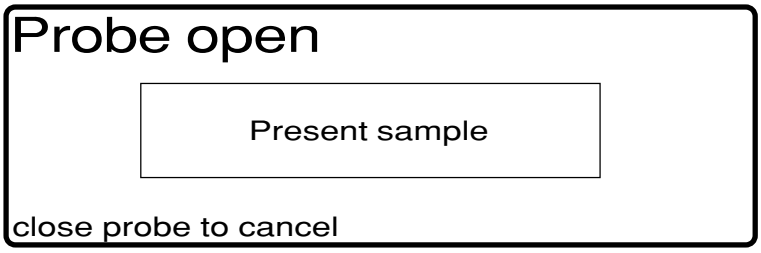
Analyzing QC Samples

BIOHAZARD: See Appendix A, *Protecting Yourself From Biohazards*.

1. If the main message shows syringe or capillary sample press **2** to select QC.

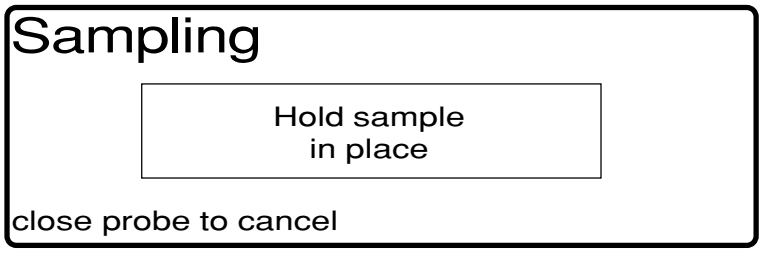


2. Lift the probe lever to the first position.

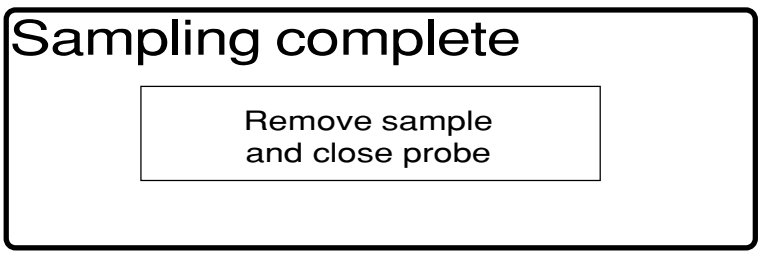


WARNING Open ampules carefully.
Use ampule breakers (Cat. 47860900L) to protect your fingers.

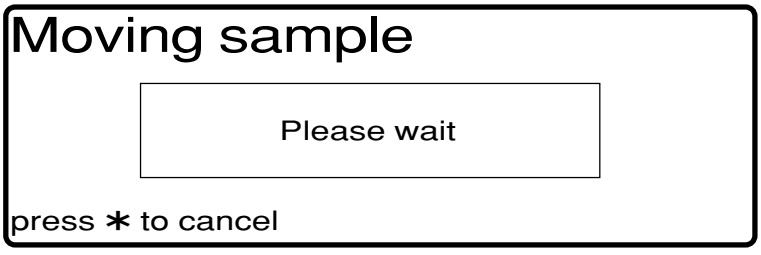
3. Present the QC sample to the probe and gently push the probe sleeve back. The 248 beeps when the probe sleeve is in the correct position and starts sampling.



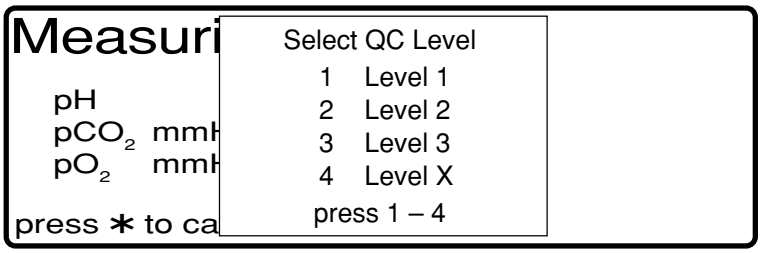
4. Hold the sample in place. The 248 beeps when sampling is complete.



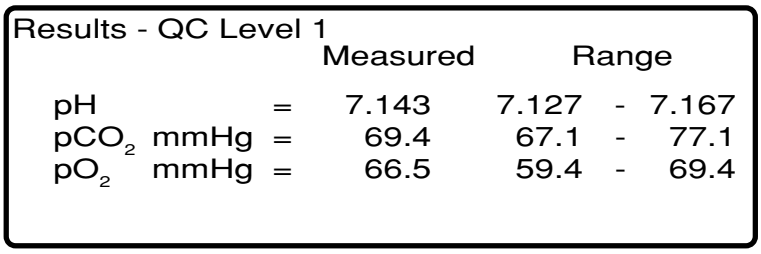
5. Remove the sample and close the probe.



Analyzing QC Samples



6. Press **1** - **4** to select the QC level. This makes sure the result is compared to the appropriate QC reference range, and reported correctly on the printer and DMS systems. If QC level is not selected the 248 assumes Level X, which has no range checking.



Example result If the measured values are outside the QC ranges set (see Section 5, *Configuring the System*) an arrow indicates if they are above or below the range.

Example Printout

```
QC Report

248-9265   11:15  Apr 11 1994
Sample No.  5062

Level 1
Lot 123456
   pH      7.143
   pCO2     69.4    mmHg
   pO2      66.5    mmHg

QC Ranges
   pH     7.127  -  7.167
   pCO2    67.1  -   77.1
   pO2     59.4  -   69.4

- - - - - - - - - - - - - - -
```

Instrument ID, time and date, and sample number

Measured values

QC ranges

While the results are displayed and printed the 248 washes the probe and sample path.

When the wash has finished the 248 returns to the **Ready** screen.

The **Ready** screen main message will show QC sample for 60 seconds. After this time, the screen reverts to the last sample type before QC was selected.

Analyzing QC Samples

QC Handling

Significant errors in QC measurements may be caused by:

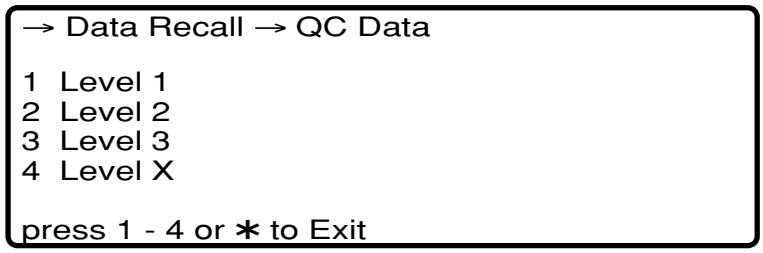
- improper storage and temperature equilibration of the QC sample,
- improper mixing of the QC sample,
- contamination of the QC sample by room air.

Always follow the manufacturer's instructions for use carefully, especially regarding the temperature of the QC before sampling. Mix the ampule thoroughly, and once opened sample the QC immediately. Do not re-use an opened ampule. Position the probe near the bottom of the ampule to obtain a representative sample.

Recalling the Last QC Data

The 248 retains the data for the last QC sample measured at each level.

1. From **Ready** press **#** for **menu**, **4** for **Data Recall** and **2** for **QC Data**.



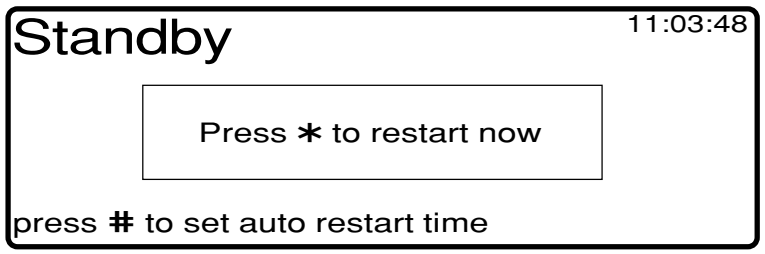
2. Press **1** - **4** to select the QC level.
3. The QC data is recalled to the display.
4. Press **#** to print the data.

   The printout shows the date and time the QC sample was analyzed, not the time of recall.

Entering Standby Mode

This routine conserves reagents. During **Standby** the sensors are kept wet and the pump tubes moved from time to time to keep them in good condition. The 248 does not calibrate while in standby mode, but automatically calibrates as required when restarted, before allowing sample measurements.

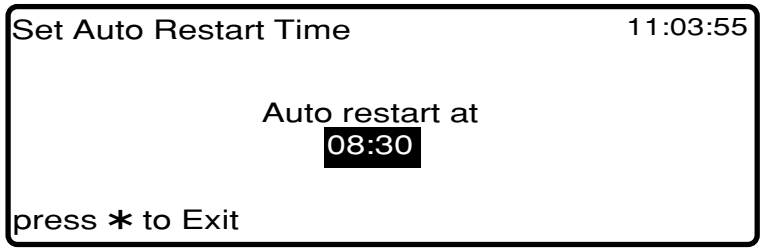
1. From **Ready** press **#** for **menu** and **7** for **Standby**.



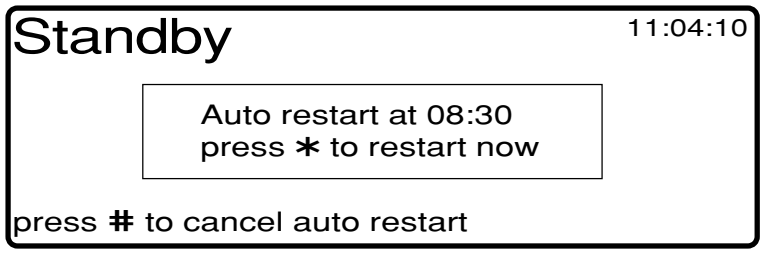
2. You can restart the 248 from standby mode in two ways:
   a. press ∗ to restart the 248 immediately, or
   b. set an auto restart time. If a time is set, the 248 automatically restarts at that time.

Setting Auto Restart Time

1. To set the auto restart time press **#**.



2. Enter the time required and press ∗ to Exit. If the time displayed is the time you want for auto restart, just press ∗.



3 Maintaining the System

The 248 has been designed to reduce the need for maintenance to an absolute minimum. However, careful attention to the few regular preventative maintenance routines which are required will be more than repaid by reliable, troublefree performance. To help with this, a maintenance schedule is provided (see example on Page 3-3, working copies are inside the front cover of this manual).

The maintenance frequency is based on analyzing 20 - 30 samples/day. Increase the maintenance frequency if your laboratory analyzes more than 30 samples/day.

We recommend using the **Disinfect** routine (Page 3-8) before carrying out the following maintenance routines:

- replacing the pump tubing, cleaning and lubricating the rollers,
- replacing the reference sensor cassette,
- filling/replacing the pH sensor,
- replacing the pCO_2 and pO_2 sensors,
- replacing the probe and tubing, probe housing and probe protector,
- replacing the pre-heater tube.

The **Deproteinize, Condition, Prime, Disinfect** and **Stop System** routines are in the Maintenance Menu.

Maintenance should be carried out with the instrument functions suspended, using the **Stop System** routine.

When replacing the pump tubing kits drain the 248 using the **Prime** routine.

```
Main Menu → Maintenance

1  Deproteinize          5  Stop System
2  Condition
3  Prime
4  Disinfect

press 1 - 5 or * to Exit
```

Daily Maintenance

Equipment: Buffer Pack, (473496) as required; Wash Pack, (473497) as required; 10% v/v bleach; clean tissues.

1. Check levels of reagents and replace if necessary. With typical use the reagents will need replacing every 10 to 14 days. Replace the reagents if 30 days usage has been exceeded. Agitate the buffer pack daily to incorporate any solution that may have condensed on the inside of the bottles.
2. Check the waste bottle and empty if necessary (Page 3-4).
3. Wipe the probe sleeve, sample area, reagent compartment and external surfaces with clean tissues moistened with 10% v/v bleach. Do not spray into the measurement block.

Daily Maintenance

NOTE: Do not use any cleaning material containing alcohol as this could cause certain components to crack.

4. Clean the drip tray. Check it is located properly and the connector is fitted (Page 3-22).
5. Check there is enough paper in the printer - if the red stripe is showing replace the paper (Page 3-23).

Weekly Maintenance

Equipment: As for daily maintenance, plus cal gas cylinder (Cat. 001 84 146E, or 477434000 or local equivalent – contact distributor) as required; slope gas cylinder (Cat. 001 84 147F, or 477438000 or local equivalent – contact distributor) as required; pH fill solution (Cat. 478533) and Reference fill solution (Cat. 478822) as required.

Carry out daily maintenance and use the **Disinfect** routine (Page 3-8), and:

1. Check the level of fill solution in the sensors. The reference sensor should be filled to the line and the pH sensor should be almost full with only a small bubble at the top. Refill the sensors if necessary, Pages 3-17 and 3-19.

   NOTE: The pCO_2 and pO_2 sensors contain fill solution but cannot be refilled. Slight discolouration of the fill solution in these sensors is normal.
2. Check the sensors for air bubbles in the fill solution. Remove the sensors and tap to dislodge air bubbles, Pages 3-17 and 3-19.
3. Deproteinize and condition the sensors. (Deproteinizing and conditioning may be prompted more frequently than once a week - see Section 5, *Configuring the System*).
4. Check the reference sensor for bubbles in the fill solution and for crystal growth. If air bubbles are present, remove the sensor and tap it to dislodge air bubbles. If crystal growth is present, remove the sensor, empty the fill solution and rinse with deionized water, then refill the sensor with reference sensor fill solution, Cat. 478822. Clean off excess fill solution using lint free tissue and deionized water. Push a clot removal line into the vent hole to clear any fill solution crystals. See Page 3-19, *Replacing the Reference Sensor Cassette* for details.
5. Check gas cylinder pressure. Replace cylinder if pressure is less than 300 psi.

Quarterly Maintenance

Equipment: As for daily/weekly maintenance, plus pump tubing kits (Cat. 673254 and 673257 or 673358); screwdriver, supplied with the Spares and Accessories Kit; mild detergent; drip tray (Cat. 673255) as required.

Carry out daily and weekly maintenance and:

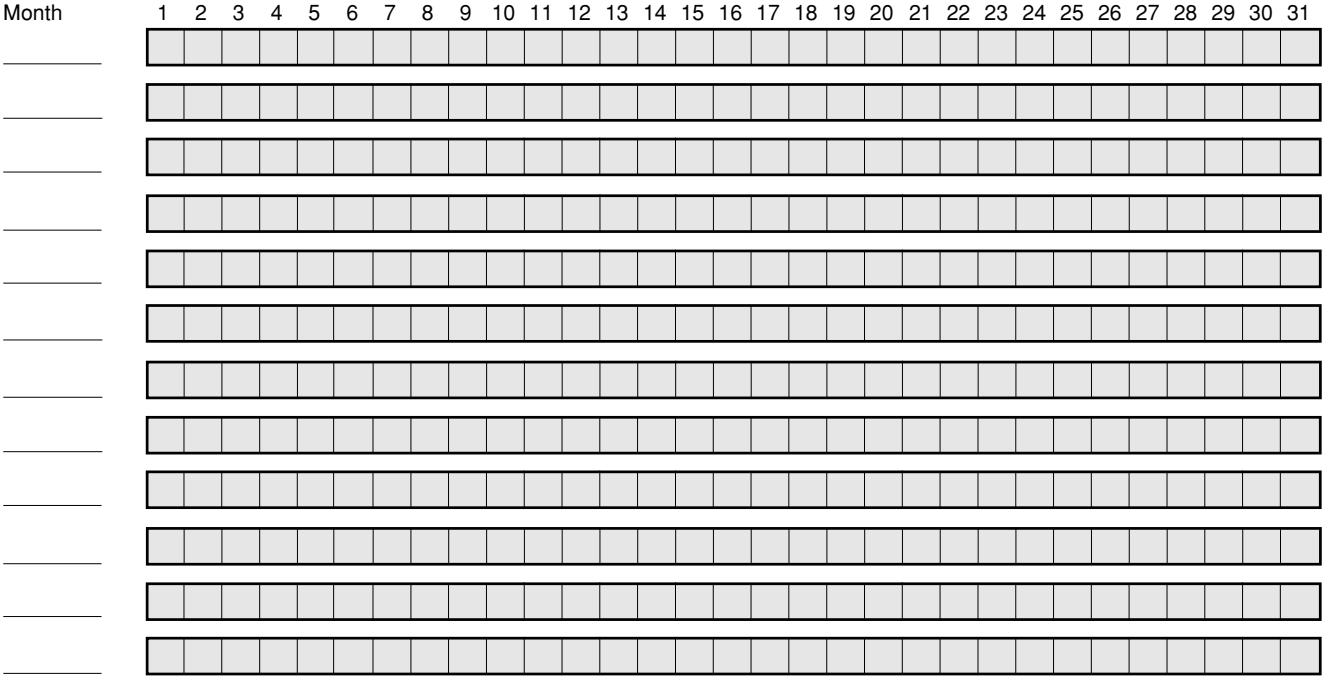
1. Replace the pump tubing and the pump rotor mouldings, and clean and lubricate the pump roller assembly. Date the pump tubing labels a maximum of 3 months ahead, Page 3-13.

   NOTE: Under heavier workload conditions it may be necessary to replace the pump tubing more frequently.
2. Replace the drip tray if it is becoming difficult to clean, Page 3-22.

✔ when maintenance has been carried out. **Start Date . . . . . .**

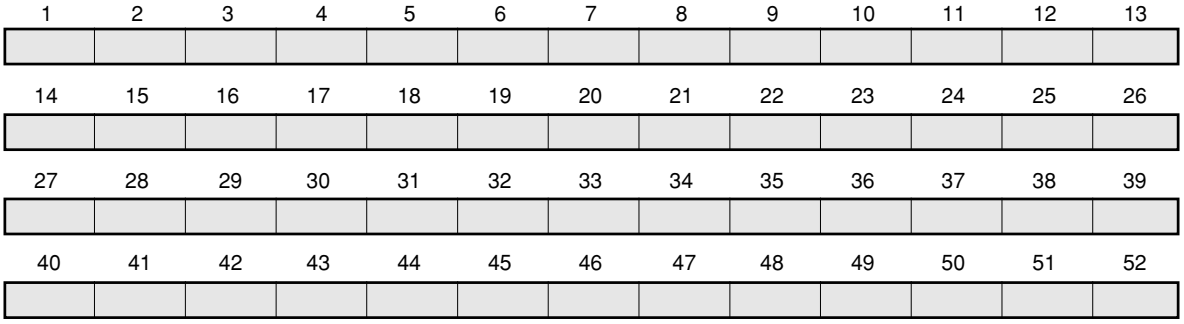
Daily

• check calibrant levels and 'change by' date, shake buffer pack • wipe sample area, drip tray and external surfaces • check drip tray is fitted and connected properly •



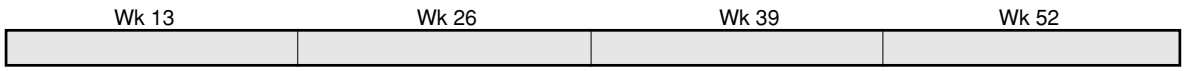
Weekly

• check fill solution in pH and reference sensors, and debubble sensors • deproteinize/condition sensors • check gas cylinder pressure and flow rate •



Quarterly

• Use Disinfect routine • replace pump tubing, clean and lubricate rollers • replace drip tray if difficult to clean •



Six-monthly

• replace bottle tubing •

Six Monthly Maintenance

Equipment: As for daily/weekly/quarterly maintenance, plus Bottle tubing kit (Cat. 673250).

Carry out daily/weekly/quarterly maintenance and:

1. Replace the bottle tubing.

Emptying the Waste Bottle

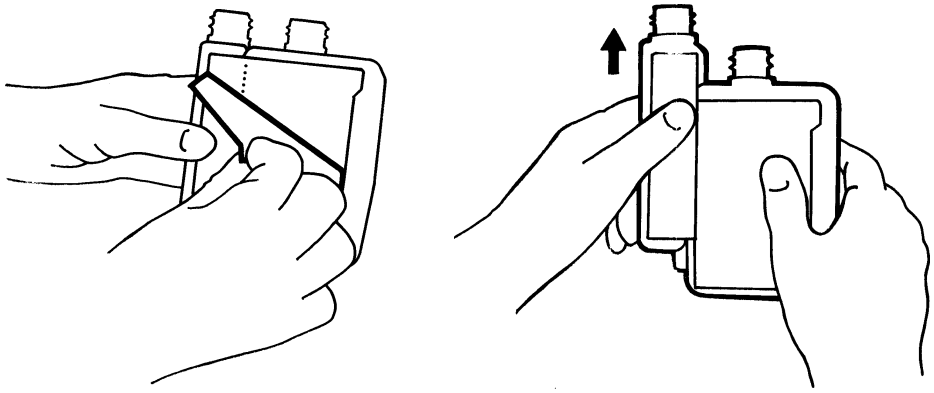
BIOHAZARD: see Appendix A, *Protecting Yourself from Biohazards*.

Equipment: Disinfectant or sodium hypochlorite.

The display prompts you to empty the waste bottle. You can choose how often you want the prompt to appear (see Page 5-5, *Setting the Maintenance Prompts*).

1. Stop the 248 system:
   a. From **Ready** press **#** for **menu**, **2** for **Maintenance** and **5** for **Stop System**.
2. Remove the waste bottle.
   a. Lift the front cover.
   b. Carefully pull the waste bottle forwards, tilting the top slightly away from you.
3. Dispose of the waste in accordance with your laboratory guidelines.
4. The Wash bottle and the 7.3 buffer bottle from the Buffer Pack can both be used as new waste bottles when they are empty.
   a. Peel off the top label from the top righthand corner to expose the waste label. To use the 7.3 buffer bottle separate the label at the perforation. Slide the 6.8 buffer bottle off and discard.

Figure 3-1. Separating Buffer Bottles

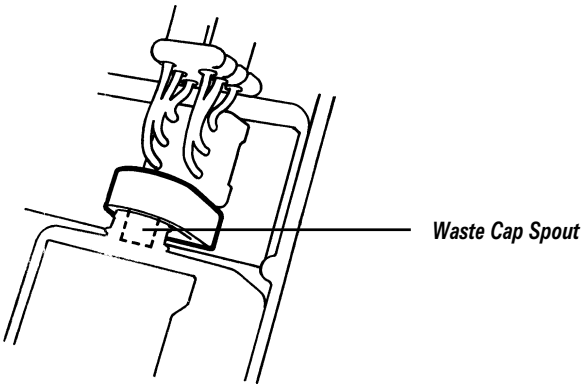


Emptying the Waste Bottle

NOTE: Siemens Healthcare Diagnostics recommends that approximately 10 mL of disinfectant or sodium hypochlorite is put into the waste bottle before placing it in position.

5. Replace the waste bottle:
   a. Tilt the top of the bottle away from you and slide the bottle into position.
   b. Check that the neck of the waste bottle is positioned underneath the rubber cap. The waste cap spout should be inside the neck of the waste bottle.

Figure 3-2. Replacing the Waste Bottle



6. Lower the cover.
7. Press ∗ to restart the 248. Press ∗ twice more to exit to the **Ready** screen. The 248 will calibrate.
8. When the **Ready** screen reappears, press ∗ to cancel the waste bottle prompt.

Changing the Reagents

Check the reagent levels and 'change by' date regularly. If either the Buffer Pack or Wash bottle is empty, or if the Buffer bottle is past the 'change by' date replace it as follows.

1. Stop the 248 system:

   From **Ready** press **#** for **menu**, **2** for **Maintenance** and **5** for **Stop System**.

2. Raise the front cover and remove the empty bottle. The Wash bottle and the 7.3 buffer bottle from the Buffer Pack can both be used as new waste bottles.

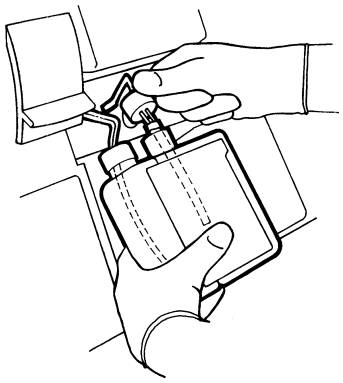
   a. Peel off the top label from the top righthand corner to expose a waste label. To use the 7.3 buffer bottle separate the label at the perforation. Slide the 6.8 buffer bottle off and discard.

3. Remove the cap from the replacement bottle.
4. Feed the bottle tubing into the neck of the bottle and into the solution.

Changing the Reagents

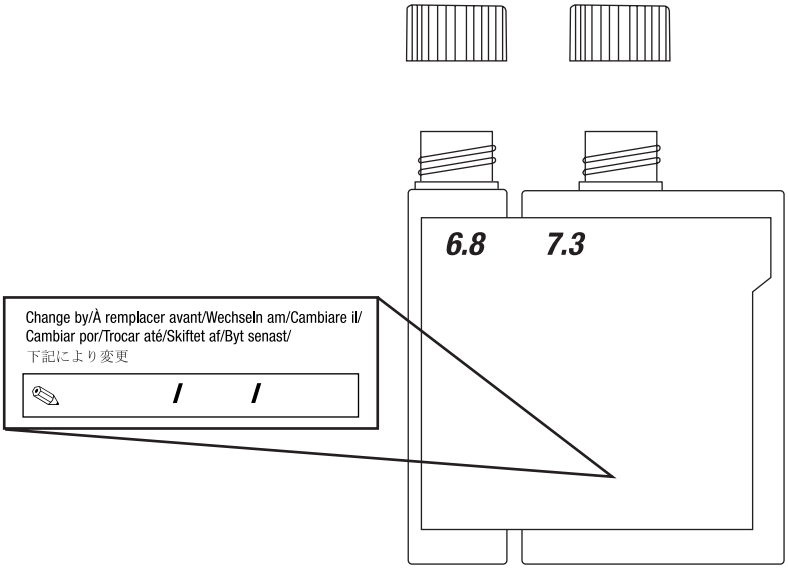
5. Tilt the top of the bottle slightly away from you and slide into position.

Figure 3-3. Positioning the Reagents



6. Press the cap firmly onto the neck of the bottle.
7. If you are changing the buffer bottles, date the label 30 days ahead.

Figure 3-4. Dating the Buffer Label



8. Lower the front cover and press ✱ to restart the 248.
9. From **Maintenance** press **3** for **Prime**.

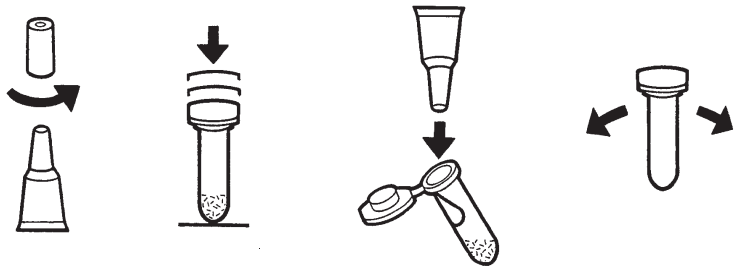
   The **Prime** routine pumps the new reagent through the system.
10. When the **Prime** routine has finished, press ✱ twice to exit. The 248 calibrates on return to the **Ready** screen.

Deproteinizing the Sensors

Equipment: Deproteinizer/Conditioner pack or Deproteinizer (Cat. 105610).

1. Activate the Deproteinizer by mixing D1a and D1b.
   a. Tap the vial (D1b) before opening to return all the pepsin powder to the bottom of the vial.
   b. Gently add solution D1a.
   c. Cap and shake the vial until the powder has dissolved, this will take a few seconds. The powder must be completely dissolved before the solution is used.

Figure 3-5. Activating the Deproteinizer



2. From the **Ready** screen press **#** for **menu**, **2** for **Maintenance** and **1** for **Deproteinize**.
3. Following the instructions on the screen, lift the probe to the first position and present the deproteinizing solution.

   Hold the solution in place until prompted to remove it, then close the probe.
4. The Deproteinizer is left in contact with the sensors for 5 minutes, and the screen shows the time remaining. When deproteinizing is finished, the 248 washes and will calibrate on return to the **Ready** screen.

   You can cancel the Deproteinize routine to measure a sample by pressing **∗**. The 248 washes and will calibrate on return to the **Ready** screen.

Conditioning the Sensors

Equipment: Deproteinizer/Conditioner pack or Conditioner (Cat. 478701).

1. From the **Ready** screen press **#** for **menu**, **2** for **Maintenance** and **2** for **Condition**.
2. Following the instructions on the screen, lift the probe and present the conditioning solution.

   Hold the solution in place until prompted to remove it, then close the probe.
3. The Conditioner is left in contact with the sensors for 5 minutes, and the screen shows the time remaining. When conditioning is finished, the 248 washes and will calibrate on return to the **Ready** screen.

   You can cancel the Condition routine to measure a sample by pressing **∗**. The 248 washes and will calibrate on return to the **Ready** screen.

Using the Disinfect Routine

BIOHAZARD: See Appendix A, *Protecting Yourself From Biohazards*.

CAUTION: Disinfectant should be used in accordance with the manufacturer's instructions.

We have tested the following disinfectants for compatability with our sensors:

- 2% activated glutaraldehyde solution
- 1% or 2% Virkon
- 10% v/v bleach

2% activated glutaraldehyde solution has no detrimental effect on the sensors, and is available from Siemens as Cat. 673390.

CAUTION: Both Virkon and 10% v/v bleach affect the reference sensor. To prevent damaging the reference sensor if you use either of these two disinfectants, you must remove it and replace it with an old sensor.

Alternatively, use a Test blank sensor - ref (TB5), Cat. 673396000.

Equipment: Bleach or Virkon or Activated glutaraldehyde solution (Cat. 673390); Test blank sensor (Cat. 673396000) as required.

The **Disinfect** routine allows disinfectant to be pumped through the probe and sample path and left in place for 10 minutes. It should be carried out before replacing the pump tubing, sensors or the probe and tubing. It should also be carried out after analyzing a sample known or suspected to contain dangerous pathogens.

NOTE: To prevent protein fixation, we recommend deproteinizing the system (Page 3-7) before using the **Disinfect** routine.

1. From **Ready** press **#** for **menu**, **2** for **Maintenance** and **4** for **Disinfect**.
2. Following the instructions on the screen, lift the probe to the first position and present the disinfectant.

   Hold the solution in place until prompted to remove it, then close the probe.
3. The Disinfectant is left in the measurement block for 10 minutes, and the screen shows the time remaining. When the routine is finished, the 248 washes and will calibrate on return to the **Ready** screen.

   You can cancel the Disinfect routine to measure a sample by pressing *****. The 248 washes and will calibrate on return to the **Ready** screen.
4. You can remove the probe and tubing and measurement block tubing, Page 3-24, and sample pump tubing, Page 3-13, and soak for 10 minutes in 10% v/v bleach.

CAUTION: Always observe good laboratory practices when handling any component of the 248 under biohazardous conditions. Siemens is unable to accept responsibility for the effectiveness of the disinfectant used or of the **Disinfect** routine.

Stopping the 248 System

This routine suspends instrument functions, for example, calibrations, while you are carrying out routine maintenance such as changing the reagents, sensors, tubing, gas cylinders and pump tubing, or while clearing blockages.

If Beeper On is selected (see Page 5-6, *Changing Beeper Option*) the 248 will beep after 30 minutes in Stop System. Press **#** to cancel the beeper.

Do not leave the 248 system stopped for longer than necessary, as this may damage the sensors and pump tubing.

Stopping the 248 System

1. From **Ready** press **#** for **menu**, **2** for **Maintenance** and **5** for **Stop System**.

2. Carry out the maintenance task.
3. Press **∗** to restart the 248 system.

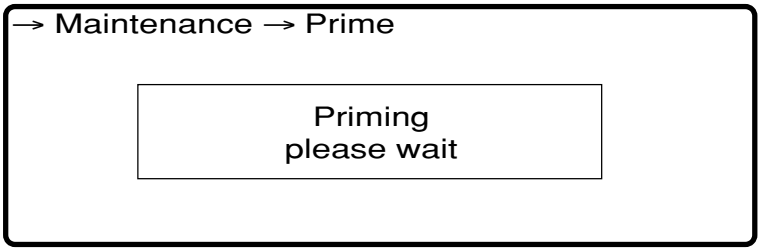
   The 248 calibrates on return to the **Ready** screen.

Using the Prime Routine

This routine drains and pumps solution through the 248 and should be used when replacing the pump tubing, changing reagents or pumping disinfectant through the manifold.

Draining the 248

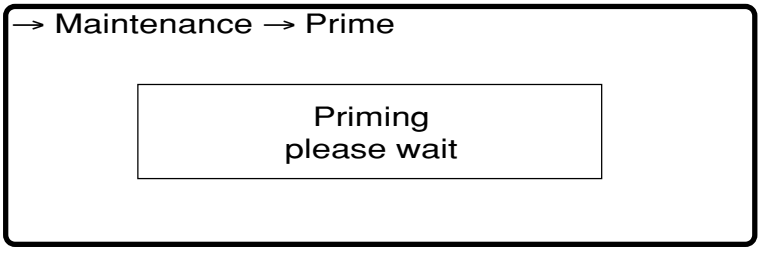
1. Raise the front cover and remove the Buffer pack and Wash bottle. Do not remove the Waste bottle. Place tissues under the bottle tubes to catch any spillage.
2. From **Ready** press **#** for **menu**, **2** for **Maintenance** and **3** for **Prime**.



3. The 248 pumps and drains the system.

Priming the 248

1. Follow the appropriate maintenance procedure, then from **Ready** press **#** for **menu**, **2** for **Maintenance** and **3** for **Prime**.
2. The 248 primes the system.



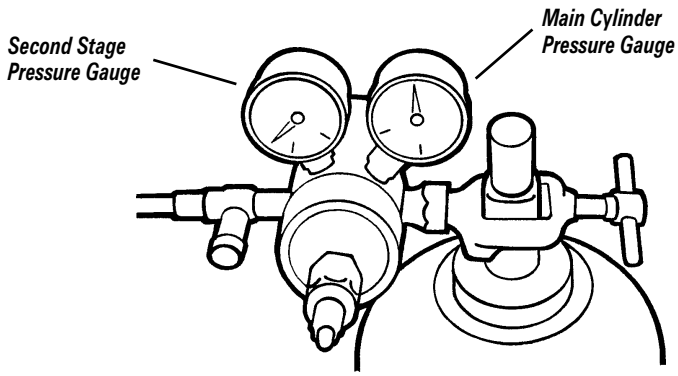
   If necessary, repeat the routine to thoroughly prime the system.
3. Press **∗** twice to return to the **Ready** screen.

Checking the Gas Pressure and Changing the Cylinders

Checking the Gas Pressure

1. Check the main cylinder and second stage pressure.

Figure 3-6. Checking the Gas Pressure



The main cylinder pressure must be higher than 300 psi. The second stage pressure must be 4 ± 1 psi.

2. If the main pressure is less than 300 psi, check that the cylinder valve is open. If it is and the pressure is low, the cylinder is empty. Change the cylinder.

Changing the Cylinders

⚠ **CAUTION:** The instructions given are for Siemens gas cylinders and regulators and we recommend the use of these at all times. If you use other cylinders and regulators they must meet the following specfication:

- Only certified value gas cylinders should be used.

  For calibration gas the value should be 5% CO_2 (acceptable range 4 to 6%) and 12% O_2 (acceptable range 10 to 14%), balance N_2.

  For slope gas the value should be 10% CO_2 (acceptable range 8 to 12%) and 0% O_2 (acceptable range 0 to 2%), balance N_2.

  The gas values used must be entered (see Section 5, *Configuring the System*).

- The regulator must have a low diffusion diaphragm to prevent selective diffusion and alteration of the gas values. All fittings must be leak free. The regulator must have a low flow precision needle valve for gas flow adjustment and supply 4 ± 1 psi at a flow of up to 20 cc/minute. When the needle valve is closed the output psi must not rise by more than 2 psi compared to the 'open' output.

- The tubing used must not allow selective diffusion of CO_2, O_2 or N_2. Siemens tubing is designed to maximize through-flow rates, reducing the diffusion rates. The accuracy of the 248 is adversely affected by the use of diffusive tubing.

- Siemens assumes no liability for performance when non-standard equipment is used.

Changing the Cylinders

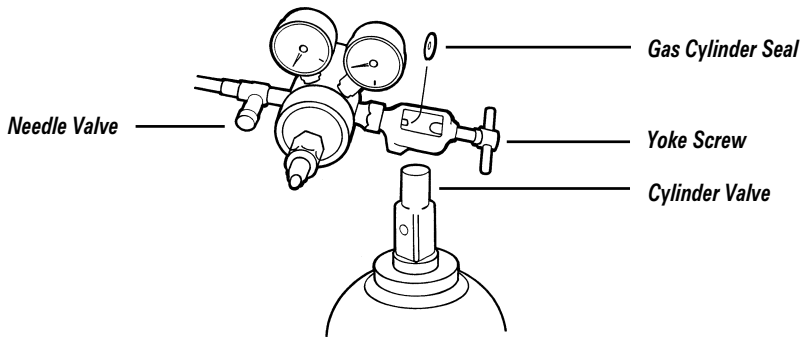
WARNING Compressed gas cylinders require careful handling. To prevent damage and possible personal injury, observe the following precautions:

- Never drop cylinders, allow them to strike each other or subject them to other strong shocks.
- Secure cylinders to a wall or bench, or place in a cylinder base support stand.
- Never drag, roll or slide cylinders, even for short distances. Use a suitable hand truck to move cylinders.
- Never tamper with safety devices in regulators or cylinders.
- Use these gases for the calibration of clinical and research instrumentation only. US Law prohibits dispensing these gases for drug use.
- The contents are under pressure – do not puncture.
- Do not use or store near heat or open flame.
- Do not expose cylinders to temperatures above 54°C (130°F) as this may cause the contents to vent or explode.
- Never throw cylinders into fire or incinerators. Follow the disposal instructions on the cylinders.

Equipment: Cal gas cylinder; Slope gas cylinder, as required.

1. Stop the 248 system, Page 3-8
2. Remove and dispose of the empty cylinder:

Figure 3-7. Changing the Gas Cylinder



   a. Close the cylinder by turning the cylinder valve clockwise.
   b. Unscrew the yoke screw to disconnect the gas regulator.
   c. Remove the cylinder to a well-ventilated, open area.
   d. Position the valve outlet so that it is facing down, away from people and loose objects.

   WARNING Avoid contact with the gas stream. Gas under pressure can cause bodily injury or damage to property.

   e. Slowly turn the cylinder valve anticlockwise to release the cylinder contents.

Changing the Cylinders

f. When the cylinder is completely vented, and the pressure is reduced to zero, label the cylinder 'empty' and dispose of it according to your laboratory protocol.

3. Install the new cylinder. Make sure you replace the cylinder with the correct type.

   a. Place the gas cylinder into its final position and secure.

   b. Remove the plastic protective wrapping from the valve assembly.

   c. Check the gas cylinder seal is in place on the regulator.

   d. Attach the gas regulator to the cylinder with the regulator nipple engaging the opening in the cylinder valve.

   e. Tighten the yoke screw firmly.

   f. Slowly open the cylinder valve until the pressure gauge indicator stops rising (approximately 3/4 of a turn, average psi is 2000).

   g. Open the cylinder valve one more turn.

   h. Listen carefully for any gas leakage. Use soapy water to check for bubbles.

CAUTION: The needle valve is easily damaged. Turn the valve gently when opening.

   i. Check the needle valve is fully open.

   j. If the gas will not be used for an extended period of time, close the cylinder by turning the cylinder valve clockwise, otherwise continue.

4. Restart the 248 system.

Checking the Gas Flow Rate

1. Initiate a full 2 point calibration:

   From **Ready** press **#** for **menu**, **1** for **Calibration** and **2** for **Full 2 Point**.

2. The gas flow rate is checked while the gas is being measured:

   a. When the calibration gas values appear on the display lift the probe lever to the first position.

   b. Fit a capillary adaptor to the end of the probe (this makes the bubbles easier to count).

   c. Present a small beaker of deionized water to the probe. The bubbles should flow at a rate of no less than 2 per second.

   d. Remove the capillary adaptor and close the probe.

3. Repeat for the slope gas:

   a. When the slope gas values appear on the display lift the probe and repeat steps 2b to 2d.

4. If either of the gas flow rates is incorrect contact your Siemens distributor.

Changing the Pump Tubing, and Cleaning and Lubricating the Rollers

BIOHAZARD: See Appendix A, *Protecting Yourself from Biohazards*

Equipment: Pump tubing kits (Cat. 673254 and 673257 or 673358); screwdriver, supplied in the Spares Kit; mild detergent; disinfectant (for example, Cat. 673390).

The 248 has two sets of pump tubes. The lefthand set is the sample pump tubing and has two tubes. The righthand set is the reagent tubing and has three tubes. For optimum performance both pump tubing kits should be changed together.

Change the pump tubing on or before the dates shown on the label.

Changing the Pump Tubing

1. Use the **Disinfect** routine and drain the 248, Pages 3-8 and 3-9. Stop the 248 system, Page 3-8.
2. Raise the front cover.

Sample Pump

Remove the tubing:

a. Remove the waste bottle.

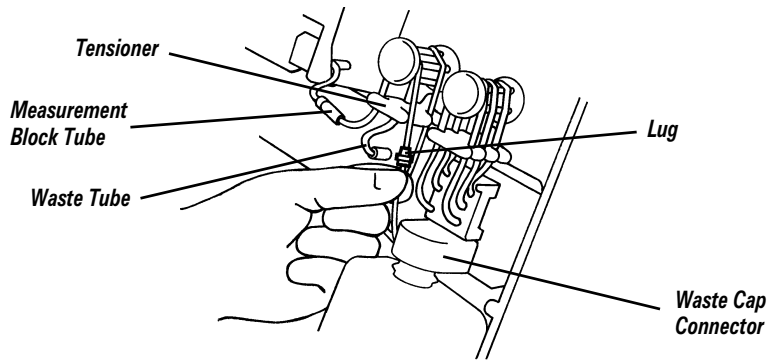
b. Disconnect the waste cap connector from the manifold.

c. Disconnect the sample tube from the measurement block tube, and the waste tube from the manifold.

d. Release the tension on the tubes by pulling each tube down and to the side until the lug is clear of the tensioner.

e. Remove the pump tubing.

Figure 3-8. Removing the Sample Pump Tubing



Reagent Pump

Remove the tubing:

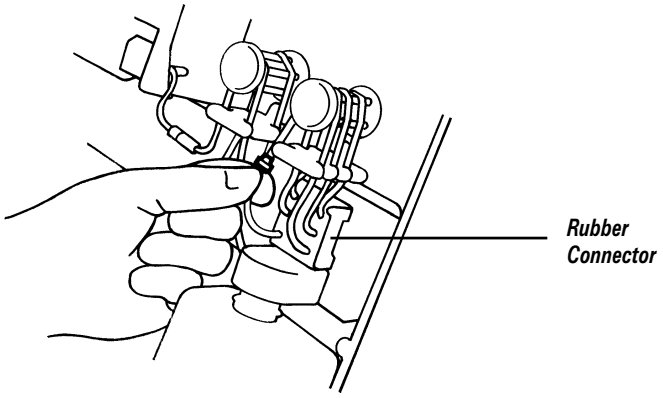
a. Disconnect the rubber connector from the manifold.

b. Release the tension on the tubes by pulling each tube down and to the side until the lug is clear of the tensioner.

c. Remove the pump tubing.

Reagent Pump

Figure 3-9. Removing the Reagent Pump Tubing

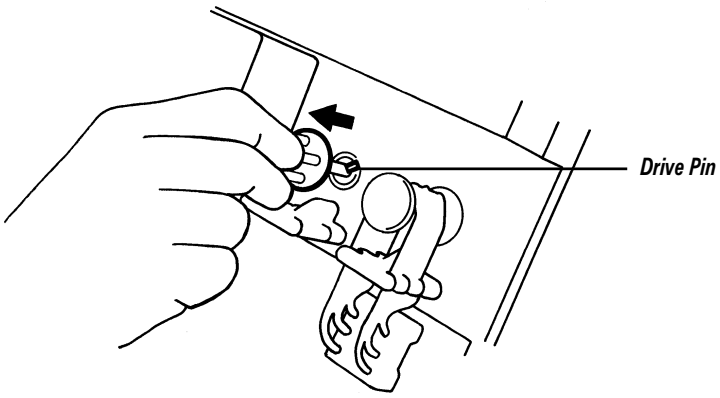


Cleaning and Lubricating the Rollers

1. Remove the finger screw holding the pump rotor in place and slide the rotor off the moulding.

   NOTE: The drive pin may drop out - if you lose it there is a spare in the Spares box.

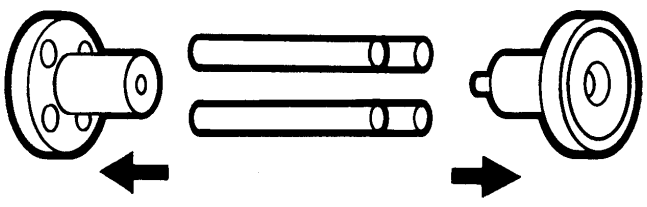
Figure 3-10. Removing the Pump Rotor



2. Remove the pump rotor mouldings:

   a. Pull the pump rotor ends apart and wash the rollers in mild detergent solution, rinse and dry with tissues.

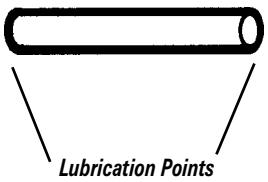
Figure 3-11. Removing the Pump Rotor Mouldings



Cleaning and Lubricating the Rollers

3. With the grease supplied, lightly lubricate each roller at the points shown. Re-assemble the rotor using the new pump rotor mouldings.

Figure 3-12. Lubricating the Rollers



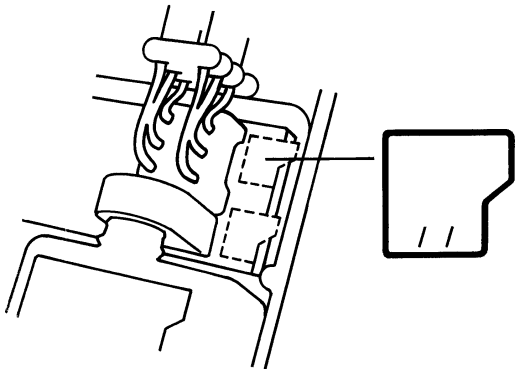
4. Replace the pump rotor. Make sure the drive pin is located correctly.

Installing New Pump Tubing

1. Install the new pump tubing:

   a. Date the label a maximum of 3 months ahead.

Figure 3-13. Dating the Pump Tubing Label



Sample Pump

2. Install the new sample pump tubing:

   a. Connect the waste cap connector to the manifold. Push firmly into position.

   b. Place the pump tubes over the rotor knob.

   c. Connect the front tube to the measurement block tube, and the back tube to the manifold.

   d. Pull the tube lugs underneath the tensioners.

   e. Replace the waste bottle.

Reagent Pump

3. Install the new reagent pump tubing:

   a. Loop the pump tubes over the rotor.

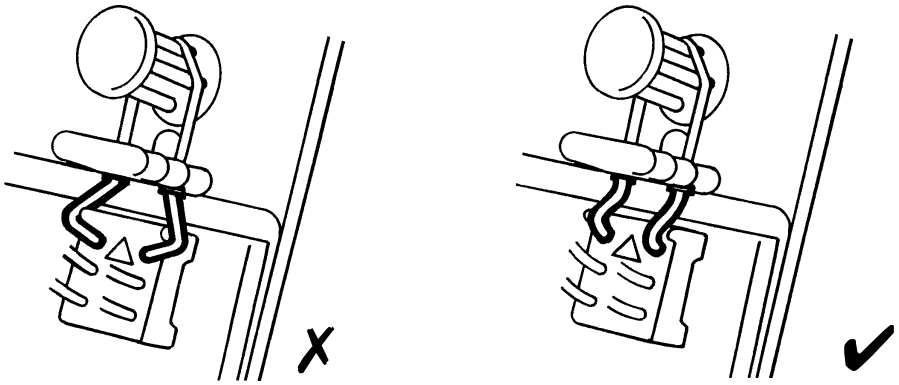
   b. Pull the tube lugs underneath the tensioners.

Reagent Pump

c. Connect the rubber connector to the manifold. Push firmly into position.

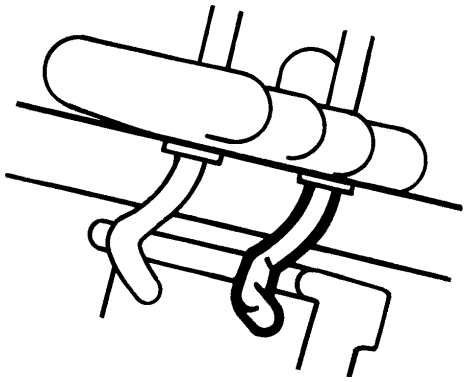
d. Refer to Figure 3-14 to make sure the tubes are fitted correctly.

Figure 3-14. Reagent Pump Tubing Correctly Installed



4. Make sure none of the pump tubes are kinked or twisted, refer to Figure 3-15.

Figure 3-15. Example of Twisted Tube



5. Replace the reagent bottles, lower the front cover and restart the 248 system.
6. Prime the 248, Page 3-9.

Refilling or Replacing the Measurement Sensors

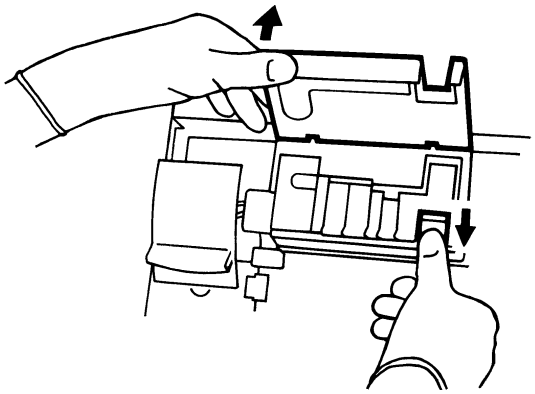
BIOHAZARD: See Appendix A, *Protecting Yourself From Biohazards*.

Equipment: pH fill solution (Cat. 478533) as required; replacement sensors, as required; disinfectant (for example, Cat. 673390).

NOTE: Although the pCO_2 and pO_2 sensors contain fill solution they cannot be refilled. To replace the pCO_2 and pO_2 sensors, follow the instructions in steps 1 - 4 and 6 - 8.

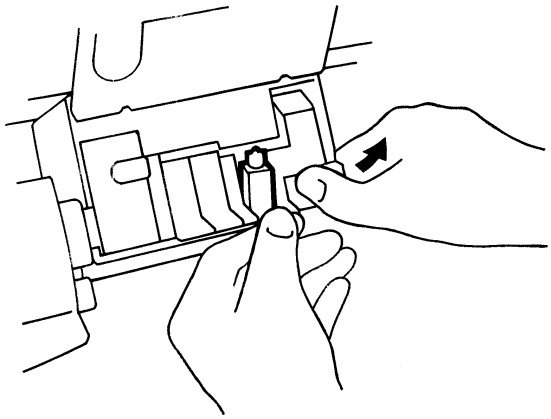
1. Use the **Disinfect** routine and then stop the 248 system, Page 3-8.
2. Raise the front cover.
3. Slide the measurement block catch down and raise the block cover.

Figure 3-16. Opening the Measurement Block Cover



4. Swing and hold the tensioner to the right and remove the appropriate sensor.

Figure 3-17. Removing a Sensor



5. Refilling the pH sensor:

CAUTION

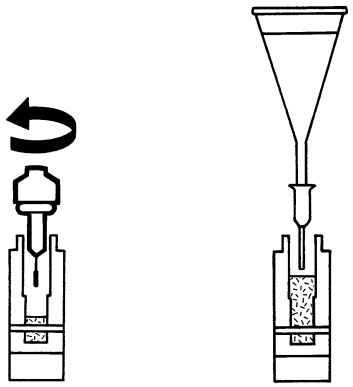
- Make sure you use pH fill solution. Do not use reference sensor fill solution.
- Do not touch the inner electrode as it is fragile and easily damaged.
  a. Unscrew the inner electrode and set aside on lint-free tissue.
  b. Empty the fill solution out of the sensor.

Refilling or Replacing the Measurement Sensors

c. Fit a needle to the fill solution container, rinse out the sensor body with a few drops of fill solution and refill the sensor almost full, leaving a small bubble at the top. Tap the sensor during filling to dislodge air bubbles.

d. Replace the inner electrode - screw down tightly. Be careful not to cross-thread the electrode. Shake the sensor down like a thermometer to dislodge air bubbles at the sensor capillary.

Figure 3-18. Refilling the pH Sensor



e. Wipe the sensor with dry, lint-free tissue and check that the 'O' ring is in position on the lefthand side, and is in good condition.

6. Tap the sensor to release any trapped air bubbles.

7. Install the sensor top first, aligning the sensor contacts. Press the bottom of the sensor into position. Gently release the tensioner and push it firmly home to make a good seal. Lower the block door, snapping it into place. Lower the front cover.

8. Press ✱ to restart the 248 system. The 248 calibrates on return to the **Ready** screen.

NOTE: Siemens recommends that you use the condition routine after refilling or replacing a pH sensor. If a new sensor is installed we recommend waiting up to 90 minutes for the system to stabilize. If you want to use the system during this settling in time frequent calibrations are necessary. Running 10 QC samples before use will promote stability.

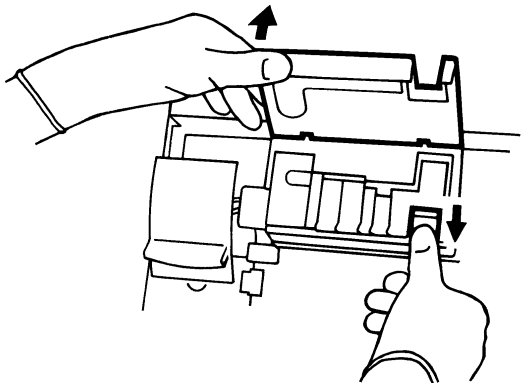
Replacing the Reference Sensor Cassette

BIOHAZARD: See Appendix A, *Protecting Yourself from Biohazards*.

Equipment: Reference sensor cassette (Cat. 478498) as required; Reference inner (Cat. 478509) as required; disinfectant (for example, Cat. 673390); clot removal line (Cat. 478645).

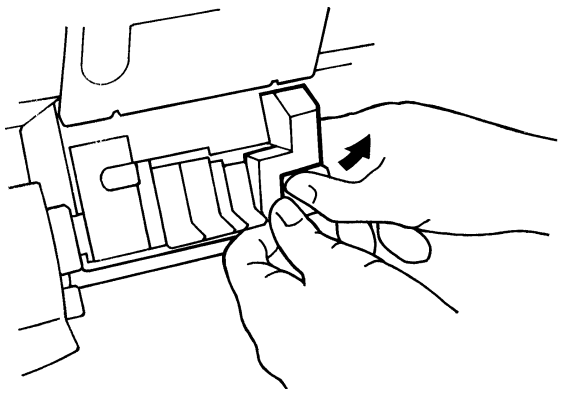
1. Use the **Disinfect** routine and stop the 248 system, Page 3-8.
2. Raise the front cover.
3. Slide the measurement block catch down and raise the block cover.

Figure 3-19. Opening the Measurement Block Cover



4. Swing and hold the tensioner to the right and remove the reference sensor.

Figure 3-20. Removing the Reference Sensor



5. Replace the reference sensor cassette:

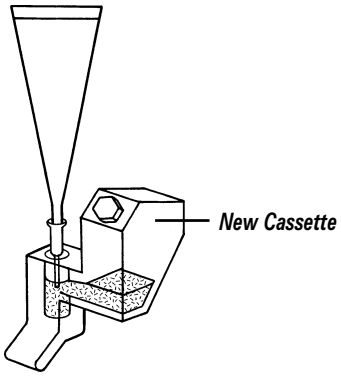
CAUTION: Make sure you use reference fill solution. Do not use pH sensor fill solution.

   a. Break the top off the reference fill solution container, and fit the needle.

   b. Slowly inject solution into the internal reference compartment of the new cassette. Continue filling until the liquid level is flush with the sensor reservoir.

Replacing the Reference Sensor Cassette

Figure 3-21. Filling the Internal Reference Compartment

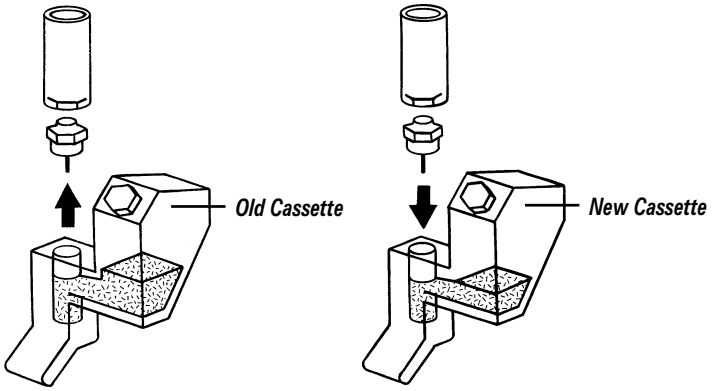


NOTE: Use the hex tool supplied to remove the reference electrode inner and reservoir cap.

⚠ **CAUTION**: Do not touch the reference electrode inner as it is fragile and easily damaged.

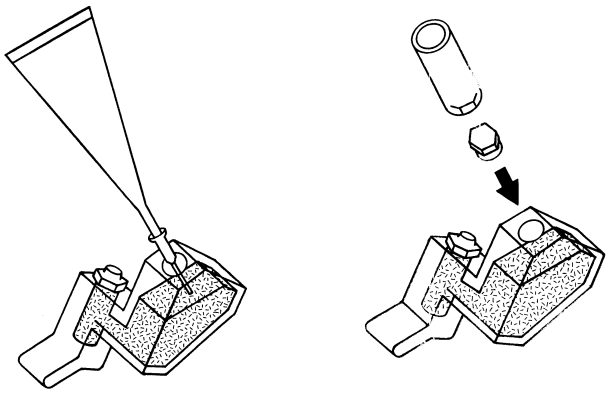
c. Remove the electrode inner from the old cassette, or, if you are installing a new reference inner remove it from its container, and screw into the new internal reference compartment. Do not cross-thread the electrode inner.

Figure 3-22. Changing the Reference Inner



d. Inject the remaining solution into the reservoir up to the fill line, and replace the reservoir cap until finger tight.

Figure 3-23. Filling the Reference Reservoir and Replacing the Cap



e. Tilt the reference cassette and tap the front with your knuckle to remove air bubbles.

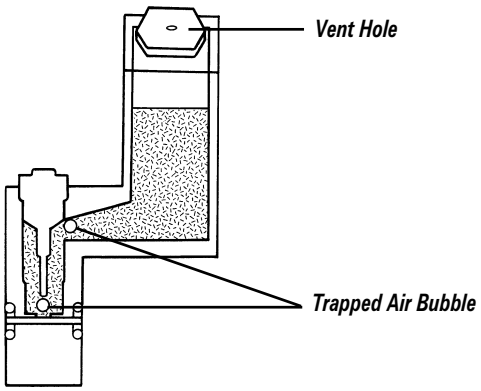
Replacing the Reference Sensor Cassette

f. Carefully clean off any excess fill solution using clean, lint-free tissue and deionized water. Push the clot removal line through the vent hole to clear any fill solution crystals.

6. Check that 'O' rings are fitted to each side of the sensor and are in good condition.
7. Refit the reference sensor top first, aligning the sensor contacts. Press the bottom of the sensor into position. Make sure all the sensors are seated correctly, then push the tensioner firmly home to make a good seal. Lower the block cover, snapping it into place.
8. Lower the front cover and restart the 248 system. The 248 calibrates on return to the **Ready** screen.

NOTE: Following a change of reference sensor cassette it is normal for the 248 to require a stabilization period of 30 minutes before optimum performance is obtained. If an over or under range condition is present on the pH channel there is probably an air bubble trapped in the reference sensor. Remove the sensor and tap it until the air bubble has been dislodged. Re–install the sensor.

Figure 3-24. Trapped Air Bubble in Reference Sensor



Replacing the Bottle Tubing

Equipment: Bottle tubing kit (Cat. 673250).

1. Drain the 248 and stop the system, Page 3-9.
2. Disconnect the three sets of bottle tubing from the manifold.
3. Install the new bottle tubing.

NOTE: If you break or lose a bottle tubing connector there is a spare in the Spares box.

4. Replace the Buffer Pack and Wash bottle:
   a. Feed the bottle tubing into the neck of the bottles and into the solution.
   b. Tilt the top of the bottle slightly away from you and slide into position.
   c. Press the cap firmly onto the neck of the bottles.
5. Lower the front cover and press ∗ to restart the 248.
6. Prime the 248, Page 3-9.

Cleaning or Replacing the Drip Tray

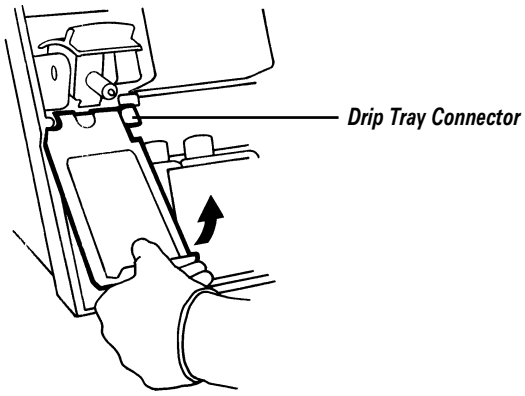
BIOHAZARD: See Appendix A, *Protecting Yourself from Biohazards*.

Equipment: Drip tray (Cat. 673255); disinfectant

1. Stop the 248 system, Page 3-8.
2. Raise the front cover.
3. Lift the probe lever to the second position.
4. Disconnect the drip tray connector from the manifold.
5. The drip tray is held in place by a magnet and you will feel some resistance as you remove it.

   Hold the drip tray at the bottom and pull upwards and out.

Figure 3-25. Removing the Drip Tray



CAUTION: The drip tray is not designed to be autoclaved and reused.

6. Clean the drip tray with disinfectant. Replacement drip trays are available (see Section 6, *Service and Supplies*) if it becomes difficult to clean.
7. Refit the drip tray. Make sure the connector is reconnected to the manifold.

WARNING The drip tray is designed to contain any blood drips, and to keep the probe clean. Failure to install it could result in a build up of blood deposits, and a potentially biohazardous situation. **Do not** operate the 248 without the drip tray in place.

8. Lower the front cover and restart the 248.

Replacing the Printer Paper

Equipment: Printer paper (Cat. 673252).

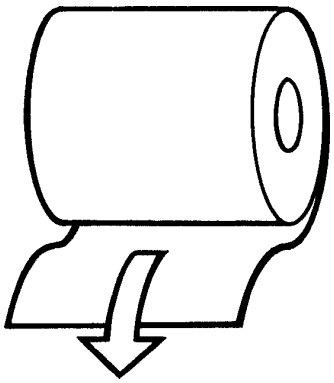
CAUTION: Only use Siemens printer paper. Other paper may affect print quality or damage the printer.

Replace the printer paper when the red stripe appears or when prompted by the display.

1. Tilt the paper cover backwards.
2. Tear off any remaining paper, and remove the old paper roll.
3. Make sure the end of the new paper roll is square. Hold the new paper roll in one hand with the paper coming from the bottom of the roll and towards you. Bend the end of the paper back slightly.

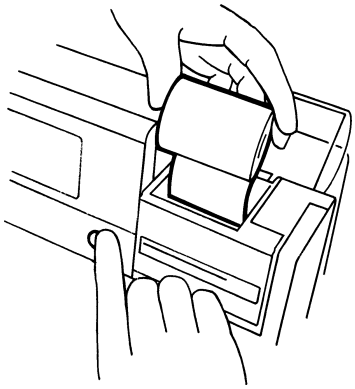
CAUTION: Make sure you feed the paper in correctly. If the paper is fed in incorrectly the printer will not print, and it may cause paper jams.

Figure 3-26. Loading the Printer Paper



4. Feed the paper down into the paper slot, and press the key until the feed mechanism takes up the paper and pulls it.

Figure 3-27. Feeding the Printer Paper into the 248



5. Place the paper roll in the holder. Close the paper cover.
6. Press the key again until the paper appears through the tearer at the front of the 248.
7. Test the printer, to check that the printout is clear, Page 4-13.

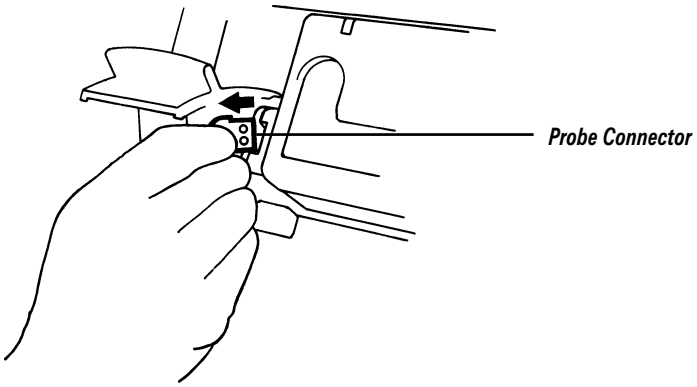
Replacing the Probe and Tubing and Probe Housing

BIOHAZARD: See Appendix A, *Protecting Yourself from Biohazards*.

Equipment: Probe and tubing kit (Cat. 673251) or Probe and housing kit (Cat. 673253), as required; disinfectant (for example, Cat. 673390).

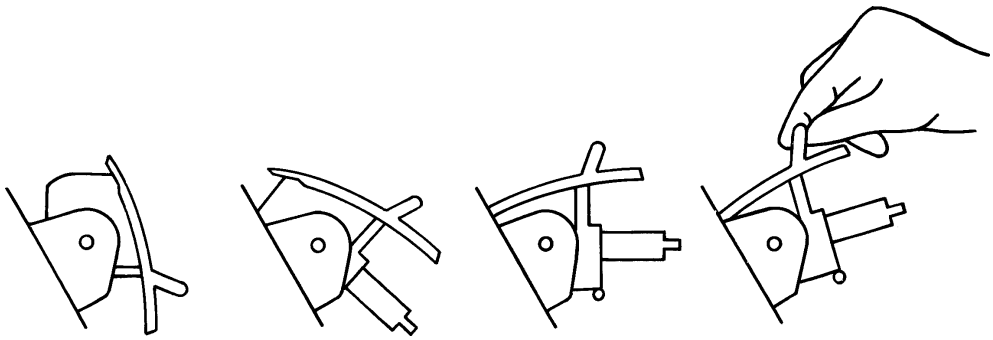
1. Use the **Disinfect** routine and stop the 248 system, Page 3-8.
2. Raise the front cover.
3. Lift the probe lever to the second position.
4. Push the probe connector to the left and pull it out of the reagent inlet connector.

Figure 3-28. Disconnecting the Probe Connector



5. Lift the probe lever past the second position and hold in place.

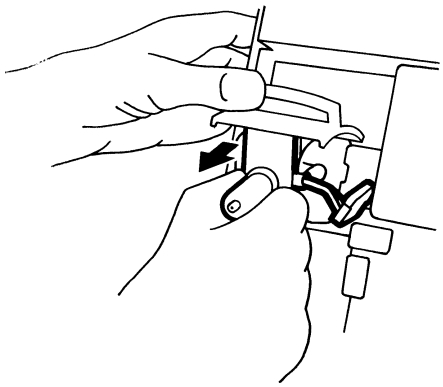
Figure 3-29. Probe Lever Positions



Replacing the Probe and Tubing and Probe Housing

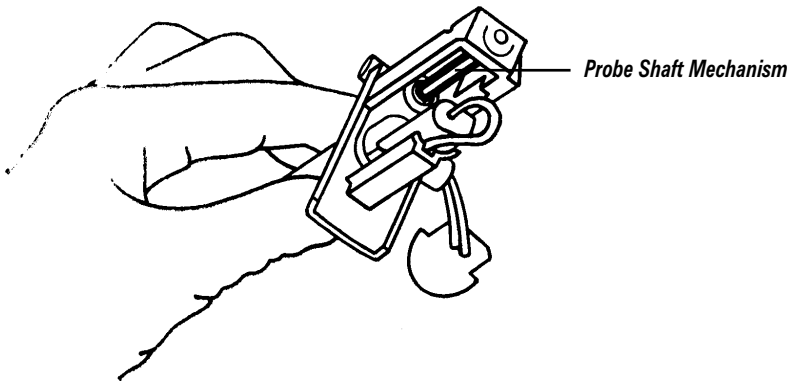
6. Carefully hold the probe sleeve and pull firmly to remove the probe housing. Release the probe lever.

Figure 3-30. Removing the Probe Housing



7. If you are replacing both the probe and the housing go to step 12. If not continue with step 8.
8. If you want to clean the probe and housing:
   - Soak the assembly for 10 minutes in 10% v/v bleach.
   - Rinse with deionized water and gently dry with tissues.
   - Lightly grease the probe shaft mechanism (use the grease supplied in the Spares box).

Figure 3-31. Greasing the Probe Shaft Mechanism



9. Disconnect the probe tubing from the housing. Pull the probe out of the housing. Discard the old part.

WARNING Make sure the old probe is disposed of safely, in accordance with your laboratory guidelines.

Replacing the Probe and Tubing and Probe Housing

Figure 3-32. Disconnecting the Probe Tubing from the Probe Housing

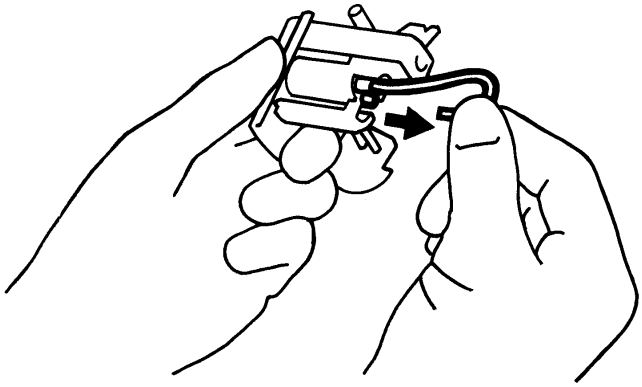
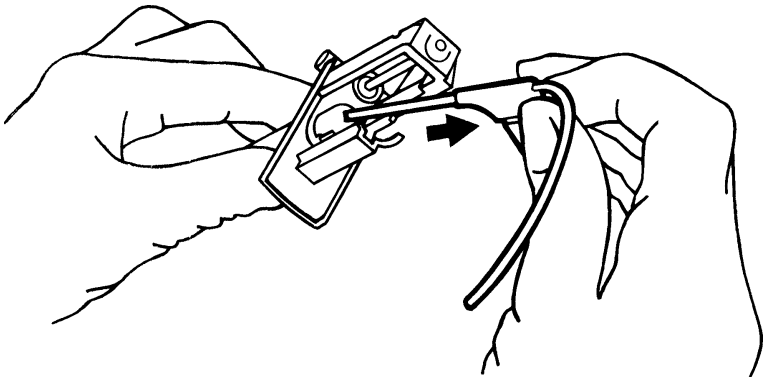
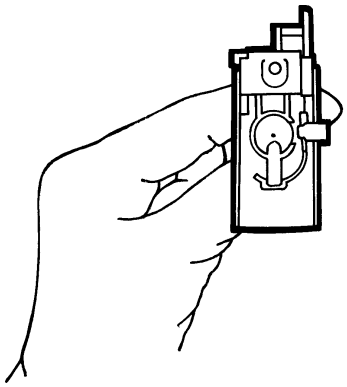


Figure 3-33. Removing the Probe from the Probe Housing



10. Using replacement parts as required, feed the probe down through the hole in the probe sleeve. Make sure it is seated correctly.

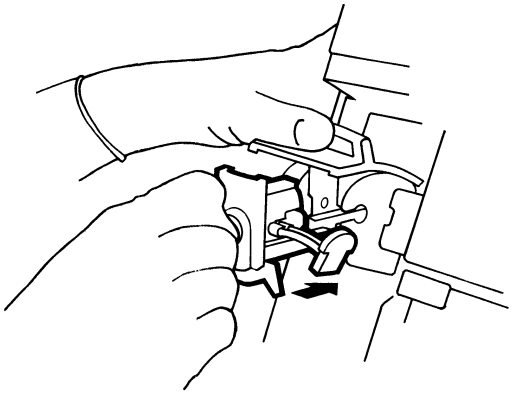
Figure 3-34. Probe Sleeve Hole



11. Connect the probe tubing to the housing.
12. Lift the probe lever past the second position and hold in place.
13. Hold the probe sleeve and slide the probe housing up the lever guides into position in the lever. Release the probe lever.

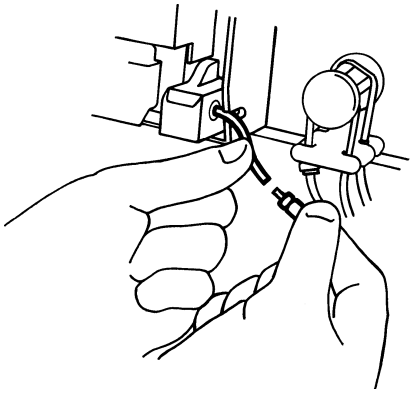
Replacing the Probe and Tubing and Probe Housing

Figure 3-35. Replacing the Probe Housing



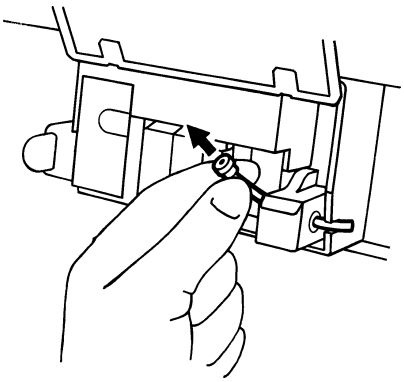
14. If necessary, fit 'O' rings to the probe connector. (Spare 'O' rings are in the Spares box.)
15. Slide the probe connector back into the reagent inlet connector.
16. Lower the probe lever.
17. Remove the reference sensor, Page 3-19 steps 3 and 4.
18. Disconnect the measurement block tube from the sample pump tubing.

Figure 3-36. Disconnecting the Measurement Block Tube



19. Remove the measurement block tube and discard.

Figure 3-37. Removing the Measurement Block Tube



Replacing the Probe and Tubing and Probe Housing

CAUTION: Take care when handling the measurement block tube as the residue from some protective gloves can adhere to the tube and therefore affect the fluid detector (FD2).

20. Fit the new measurement block tube and reconnect the sample pump tubing.
21. Replace the reference sensor, Page 3-21 step 7.
22. Lower the front cover and restart the 248.
23. To promote good flushing characteristics:
    a. Raise the probe lever to the first position.
    b. Immerse the tip of the probe in a small beaker of strong soap solution for 10 to 15 seconds.
    c. Lower the probe lever and Prime the 248, Page 3-9.

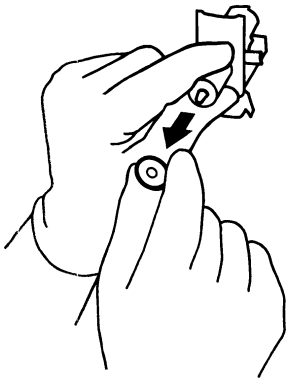
Replacing the Probe Protector

BIOHAZARD: See Appendix A, *Protecting Yourself from Biohazards*.

Equipment: Probe protector, supplied in Spares box, Probe and tubing kit, Probe and housing kit, and as Cat. 673373.

1. Remove the probe housing and probe, Page 3-24 steps 1 to 6. Do not discard the probe or housing.
2. Remove the probe protector from the probe housing.

Figure 3-38. Removing the Probe Protector



3. Fit a new probe protector.
4. Re-assemble the probe and housing, Page 3-26, steps 12 to 16.
5. Lower the front cover and restart the 248.

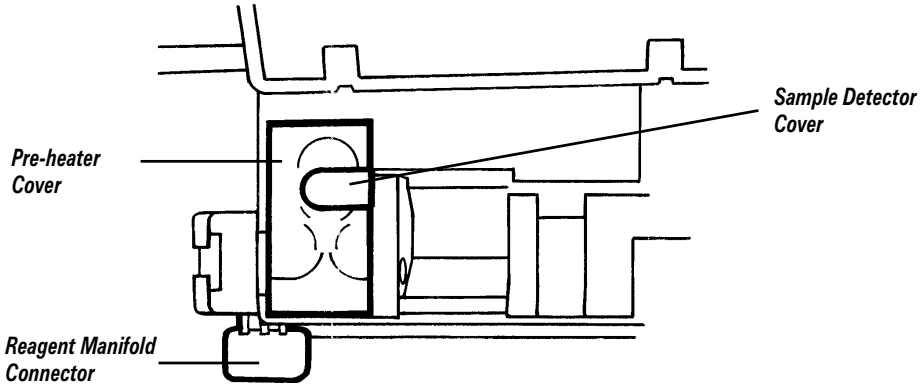
Replacing the Pre-heater Tube

BIOHAZARD: See Appendix A, *Protecting Yourself from Biohazards*.

Equipment: Pre-heater tube kit (Cat. 673256); cross-headed screwdriver; disinfectant (for example, Cat. 673390).

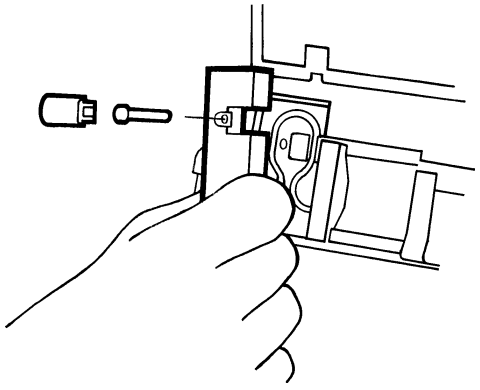
1. Use the **Disinfect** routine and then stop the 248 system, Page 3-8.
2. Remove the probe and probe housing, Page 3-24, steps 2 to 6.
3. Remove the pO_2 and pCO_2 sensors, Page 3-17, steps 3 and 4.
4. Disconnect the reagent manifold connector.

Figure 3-39. Pre-heater Components



5. Remove the sample detector cover.
6. Remove the screw from the pre-heater cover and remove the cover.

Figure 3-40. Removing the Sample Detector Cover

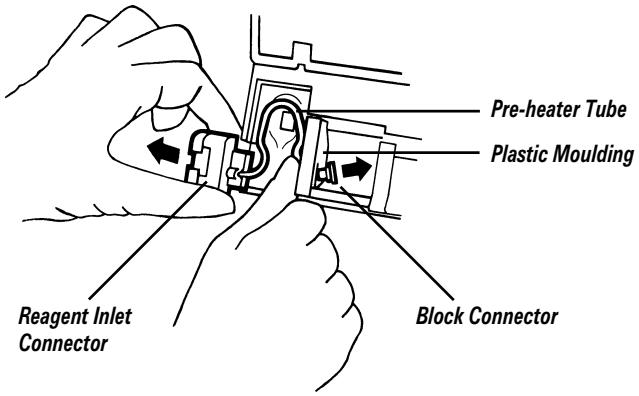


CAUTION: Handle the pre-heater tube carefully as it is quite fragile and can easily be kinked.

7. Slide the reagent inlet connector towards you. Ease the pre-heater tube from the groove in the pre-heater.
8. Carefully push the tube towards the measurement block to free the block connector.

Replacing the Pre-heater Tube

Figure 3-41. Removing the Pre-heater Tube



9. Ease the pre-heater tube under the plastic moulding.
10. Re-assemble using the new pre-heater tube assembly. Make sure that:
    - The pre-heater tube is in the pre-heater groove, and the block connector is in place.
    - The reagent inlet connector is in place.
    - The pre-heater cover and sample detector cover are replaced.
    - The reagent manifold connector is connected.
    - The sensors are replaced and seated correctly, and the block cover is closed.
11. Replace the probe and probe housing, Page 3-26, steps 12 - 16.
12. Lower the front cover and restart the 248.

Clearing Blockages

BIOHAZARD: See Appendix A, *Protecting Yourself from Biohazards*.

Always wear protective gloves when carrying out this procedure, and avoid spray contamination when clearing blockages with water.

Equipment: Clot removal line (Cat. 478645); 1 mL syringe, as required.

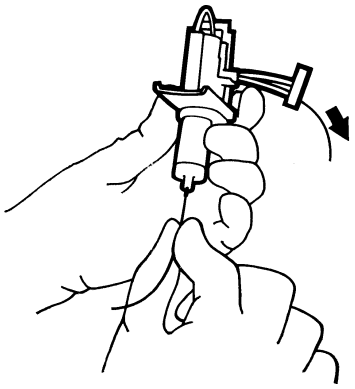
CAUTION: Only use Siemens clot removal line as other materials may damage the 248.

1. Stop the 248 system, Page 3-8.

Clearing a Blockage in the Probe

2. Remove the probe and housing, Page 3-24 steps 2 to 6.
3. Carefully thread the clot removal line up the probe until it appears through the probe connector, then pull the line through.

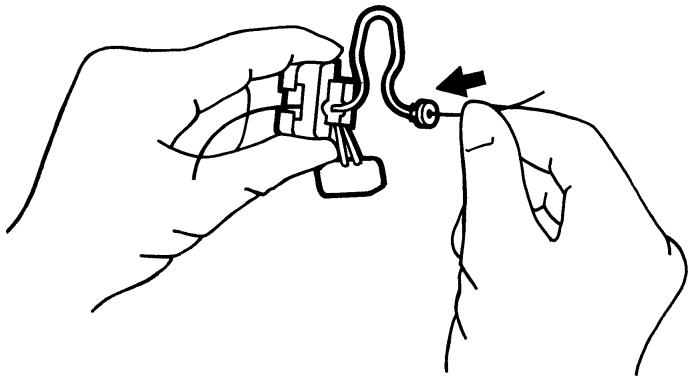
Figure 3-42. Clearing a Blockage in the Probe



Clearing a Blockage in the Pre-heater

4. Remove the pre-heater tube assembly, Page 3-29 steps 3 to 9.
5. Pass the clot removal line through the pre-heater tube then pull the line through the reagent inlet connector.

Figure 3-43. Clearing a Blockage in the Pre-Heater

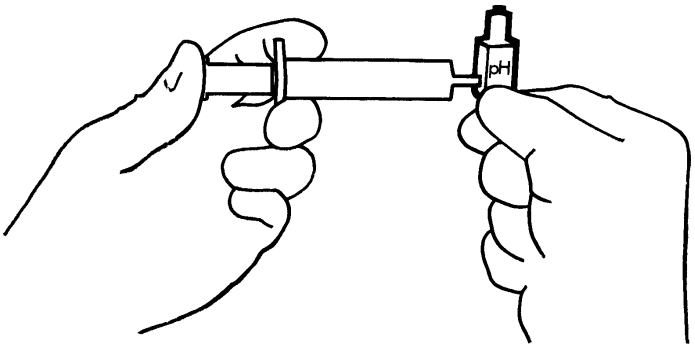


Clearing Blockages

Clearing a Blockage in the Sensors

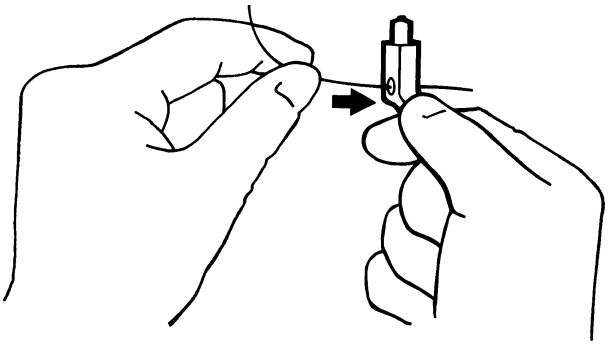
6. Remove the sensors, Page 3-17 steps 3 and 4.
7. Use the syringe filled with deionized water to carefully inject water through the sensors but apply only ***very gentle*** pressure.

Figure 3-44. Clearing a Blockage in the Sensors



8. Pass the clot removal line through the grounding block. Do not pass the clot removal line through the sensors.

Figure 3-45. Clearing a Blockage in the Grounding Block

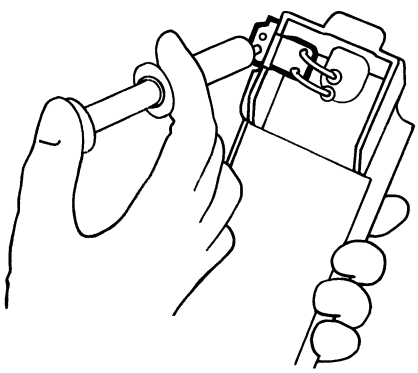


Clearing a Blockage in the Drip Tray Connector Drain Hole

9. Remove the drip tray, Page 3-22 steps 3 to 5.
10. Carefully inject water into the ports in the back of the drip tray connector.

WARNING Point the drip tray away from you while you do this.

Figure 3-46. Clearing a Blockage in the Drip Tray Connector Drain Hole

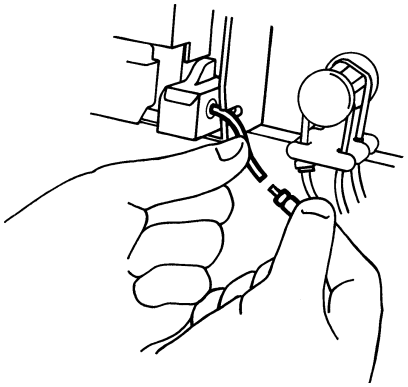


Clearing Blockages

Clearing a Blockage in the Measurement Block Tube

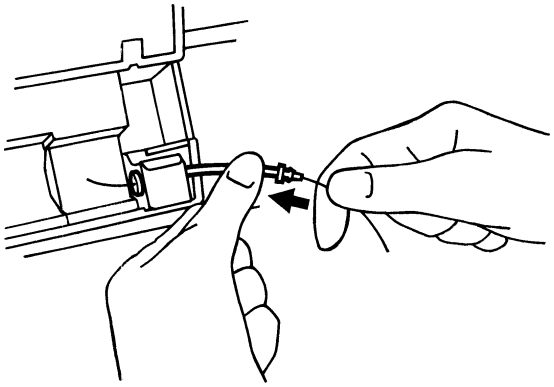
11. Disconnect the measurement block tube from the sample pump tubing connector.

Figure 3-47. Disconnecting the Measurement Block Tube



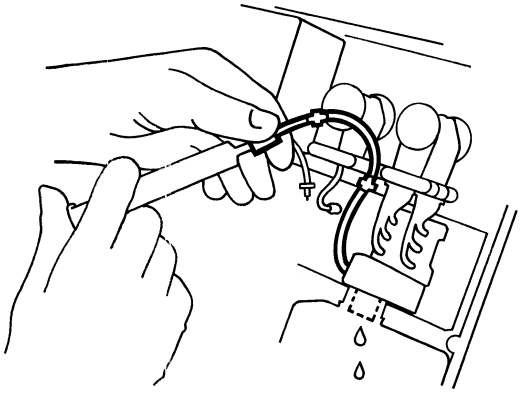
12. Thread the clot removal line up the measurement block tube until it appears in the measurement block. Pull the line through.

Figure 3-48. Clearing a Blockage in the Measurement Block Tube



13. Carefully inject water into the sample pump tubing, until water appears at the waste cap.

Figure 3-49. Clearing a Blockage in the Sample Pump Tubing



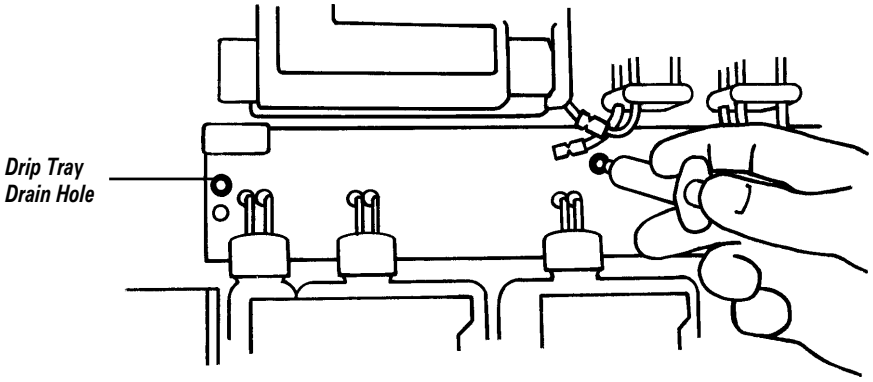
14. Reconnect the sample pump tubing to the measurement block tube.

Clearing Blockages

Clearing a Blockage in the Manifold

15. Disconnect the waste tube from the manifold.

Figure 3-50. Clearing a Blockage in the Manifold



16. Gently inject water into the waste tube port until it appears at the drip tray drain hole. Hold tissues against the drain hole to catch the drips.
17. Re-assemble the 248, restart the system and deproteinize the sensors, Page 3-7.

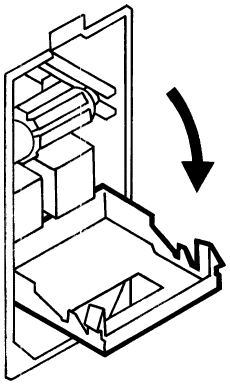
Replacing a Fuse

Equipment: Fuses (Cat. 478648 or 478916).

⚠ **CAUTION:** For continued protection against fire hazard use only the same type and rating of fuse that was fitted originally to the 248 - refer to instrument rear panel.

1. Remove the power supply cord.
2. Open the voltage selector cover with the screwdriver supplied in the Spares box.

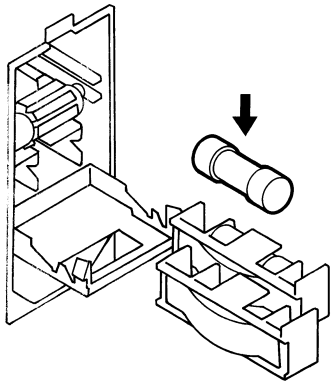
Figure 3-51. Opening the Voltage Selector Cover



3. Remove the fuse holders and replace the fuse(s).

Replacing a Fuse

Figure 3-52. Replacing Fuses

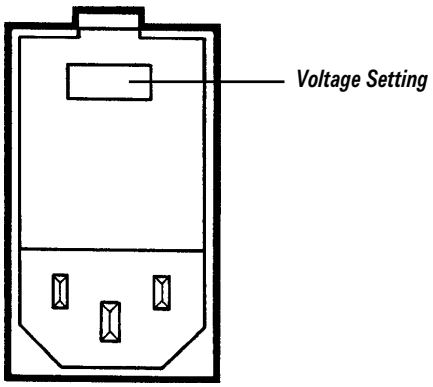


4. Close the voltage selector cover. Make sure that the voltage selector bobbin is set to the correct voltage for the local power supply.

NOTE: If you have a 230V supply, use the 240V setting on the voltage selector bobbin.

CAUTION: Do not rotate the voltage selector bobbin when it is fitted as this will damage the contacts.

Figure 3-53. Checking the Voltage Setting



5. Reconnect the power supply cord.

Shutting Down the 248

BIOHAZARD: See Appendix A, *Protecting Yourself from Biohazards*. Wear gloves while carrying out the following procedures.

Siemens recommends that the 248 is connected to the a.c. supply at all times so it is always ready for immediate use. However, if it is necessary to disconnect the a.c. supply this procedure should be followed to prevent damage to the instrument.

Equipment: Disinfectant (for example, Cat. 673390); tissues.

1. Print out the Setup report and retain so that you have a record of all the settings, Page 5-7.
2. Use the **Disinfect** routine, Page 3-8.

Shutting Down the 248

3. Disinfect the manifold and bottle tubing, and drain the system.

CAUTION: To prevent damaging the reference sensor if you use Virkon or 10% v/v bleach, you must remove the sensor and replace it with an old sensor, or a test blank sensor - ref (TB5) Cat. 673396000.

   a. Remove the Buffer pack and Wash bottle and replace with a beaker of disinfectant. Do not remove the waste bottle.

   b. From the **Maintenance** menu press **3** for **Prime**.

   c. When the Prime routine finishes, remove the disinfectant and replace with a beaker of deionized water.

   d. Press **3** to prime the 248 again. This flushes the system with water.

   e. When the Prime routine finishes remove the beaker of water. Place tissues under the bottle tubes to catch any drips.

   f. Press **3** to prime the 248 again. This drains the system.

   g. Remove the waste bottle and cap it.

4. Turn the gas cylinder valves clockwise to close the cylinders.

5. Disconnect the line cord from the power supply socket.

6. Remove the probe and housing and immerse in 10% v/v bleach for 10 minutes, Page 3-24. Rinse with deionized water, then gently wipe dry. If necessary, grease the probe shaft lightly with the grease supplied in the Spares box.

7. Remove the pH, $p\mathrm{CO}_2$ and $p\mathrm{O}_2$ sensors, Page 3-17.

8. Remove the reference sensor, Page 3-19. If you are removing the reference sensor from the 248 for more than 12 hours follow this procedure to prevent damage to the Nafion inner:

   a. Remove the electrode inner and store it in its container in saturated KCl. Do not leave the inner out of solution for longer than 10 minutes.

   b. Shake out the remaining KCl solution from the sensor cassette and rinse with deionized water. Flush the reference sensor sample path with deionized water, and allow the cassette to dry. (To reactivate the reference sensor follow the procedure for installing a new sensor cassette.)

9. Wipe the measurement block to remove any reference fill solution.

10. De-tension the pump tubes.

11. Clean the drip tray.

12. Wipe the external surfaces with tissues and 10% v/v bleach.

4 Troubleshooting the System

The 248 continually performs self-diagnostic tests to maintain integrity of results. If the instrument detects an abnormality, setup options may be reset to default and the 248 will display **Check Setup**. You can still use the 248 but the data relating to the result will be default (factory set) values.

If **Check Setup** is displayed check the setup options in **Operating Setup**, Page 5-1, **System Setup**, Page 5-4 and **Service Setup**, Page 5-7. You will also need to check the barometer calibration setting, Page 2-9. When you have checked all the setup options, exit to the **Ready** screen and press ∗ to clear the **Check Setup** message.

If the 248 does not respond to any user input refer to Page 4-14, *Using the Status Indicators,* and check status indicator 1, microprocessor.

If the roll printer is off, select **On** and **Results + Cals** (Page 5-3) as the printout may give further details of the problem.

Calibration Failures

The possible causes for standardization failure have been grouped together under the following headings: calibration or slope drift (↑, ↓ on display and printout), calibration or slope no endpoint (∗ on display and printout), calibration or slope outside range (! on display and printout), fluidics failures.

Calibration or Slope Drift

New Sensors Installed

If a new sensor has been installed, allow up to 90 minutes for it to stabilize. If the calibration still fails after this time either wait a further 90 minutes or run 10 samples using the Measurement Block - Run Test Sample routine to promote stability, Page 4-11. (This diagnostic routine has to be used to measure as the 248 has not calibrated successfully - do not use the results.)

Reference Sensor (pH drift)

Bubble in reference sensor
    De-bubble the sensor.

Nafion inner is dry due to a large bubble, or not screwed down properly, or poorly fitting
    Replace Nafion inner if dry, or refit correctly.

Sensor is clogged with crystals caused by poor filling, or bubbles creating crystal growth
    Empty sensor cassette and refill carefully with reference sensor fill solution.

Vent hole blocked
    Unblock the vent hole in the reservoir cap.

Failed membrane
    Replace sensor cassette.

See Page 3-19.

Calibration or Slope Drift

pH Sensor

Sensor needs deproteinizing/conditioning
Deproteinize/condition sensor, Page 3-7.

Bubbles in fill solution, or insufficient or concentrated fill solution
Debubble sensor, or empty and refill, Page 3-17.

The problem may also be caused by the reference sensor.

pCO_2/pO_2 Sensor

Sensor needs deproteinizing
Deproteinize sensor, Page 3-7.

Sensor failure (confirm by measurement block routine, Page 4-10)
Replace sensor.

System

Dampness around the sensors
Dry off measurement block and sensors.
Check sensor 'O' ring seals and replace if necessary.
Check sensors are seated properly, and the tensioner is pushed firmly home.

See Pages 3-17 and 3-19.

Partial blockage in sensors
Clear blockage, Page 3-31.

Gas pressure incorrect/gas flow rate incorrect/leaks in gas system/gas cylinders connected incorrectly
Check gas pressure and flow rate/cure leaks/check gases connected correctly (cal to cal, slope to slope).

See Page 3-10.

Incorrect gas values entered
Enter correct values, Page 5-2.

Barometric pressure incorrect or changed
Enter correct barometric pressure, Page 2-9.

Calibration or Slope no Endpoint

All calibrations and sample measurements must be carried out with the front cover lowered.

Reference Sensor (pH no endpoint)

Bubble in reference sensor
De-bubble reference sensor.

Nafion inner is dry due to a large bubble, or not screwed down properly, or poorly fitting
Place Nafion inner if dry, or refit correctly.

Sensor is clogged with crystals caused by poor filling, or bubbles creating crystal growth
Empty sensor cassette and refill carefully with reference sensor fill solution.

Vent hole blocked
Unblock the vent hole in the reservoir cap.

Failed membrane
Replace sensor cassette.

See Page 3-19.

Calibration or Slope No Endpoint

pH Sensor

Sensor needs deproteinizing/conditioning
Deproteinize/condition sensor, Page 3-7.

Bubbles in fill solution, or insufficient or concentrated fill solution
Debubble sensor, or empty and refill, Page 3-17.

The problem may also be caused by the reference sensor.

pCO_2/pO_2 Sensor

Sensor needs deproteinizing
Deproteinize sensor, Page 3-7.

Sensor failure (confirm by measurement block routine, Page 4-10)
Replace sensor.

System

Dampness around the sensors
Dry off measurement block and sensors.
Check sensor 'O' ring seals and replace if necessary.
Check sensors are seated properly, and the tensioner is pushed firmly home.

See Pages 3-17 and 3-19.

Partial blockage in sensors
Clear blockage, Page 3-31.

Gas pressure incorrect/gas flow rate incorrect/leaks in gas system/gas cylinders connected incorrectly
Check gas pressure and flow rate/cure leaks/check gases connected correctly, Page 3-10.

Bubble in sample path - specifically under the reference sensor
Repeat measurement and watch the solution being aspirated to determine the cause of the bubble.

Very occasionally worn pump tubing may cause instability on one or more channels
Replace tubing, Page 3-13.

Very occasionally, dampness around the pre-heater, or at the insulating bushes at either end of the sample path may cause instability
Clean/dry areas carefully.

Calibration or Slope Outside Range

Reference Sensor (pH outside range)

Bubble in reference sensor
Debubble sensor.

Nafion inner is dry due to a large bubble, or not screwed down properly, or poorly fitting
Replace Nafion inner if dry, or refit correctly.

Sensor is clogged with crystals caused by poor filling, or bubbles creating crystal growth
Empty sensor cassette and refill carefully with reference sensor fill solution.

Vent hole blocked
Unblock the vent hole in the reservoir cap.

Failed membrane
Replace sensor cassette.

See Page 3-19.

pH Sensor

Sensor needs conditioning
Condition sensor, Page 3-7.

Bubbles in fill solution, or insufficient or concentrated fill solution
Debubble sensor, or empty and refill, Page 3-17.

Sensor failure (confirm by measurement block routine, Page 4-10)
Empty and refill sensor. If problem is not solved, replace sensor.

pCO_2/pO_2 Sensor

Sensor needs deproteinizing
Deproteinize sensor, Page 3-7.

Sensor failure (confirm by measurement block routine, Page 4-10)
Replace sensor.

System

Measurement block assembly and sensors are wet
Dry off sensor block assembly and sensors.
Check sensor 'O' ring seals and replace if necessary.
Check sensors are seated properly, and the tensioner is pushed firmly home.

See Pages 3-17 and 3-19.

Worn pump tubing
Replace tubing, Page 3-13.

Gas pressure/gas flow rate incorrect/leaks in gas system/gas cylinders connected incorrectly
Check pressure and flow rate/cure leak/check gases connected correctly, Page 3-10.

Fluidics Failure - Insufficient 7.3/6.8/Wash

Run 7.3 or 6.8 buffer in the Measurement Block Routine, Page 4-10, to help diagnose the fault.

Reagents

Buffer or Wash bottles are empty
Replace buffers or Wash.

Bottle tubes do not reach the solution
Feed the tubes through the connector caps into the solutions.
See Page 3-5.

System

Blockage in sample path
Clear blockage, Page 3-31.

Leaks in sample path
Cure leaks. Check sensor 'O' ring seals and make sure sensors are seated correctly, Page 3-17.

Sucking in air on calibrant line
Cure leak.

New/greasy probe
Raise probe lever and immerse tip of probe in a strong soap solution for 10 to 15 seconds. Lower the probe lever and Prime the 248, Page 3-9.

Damaged seal in probe sleeve caused by bent probe
Replace probe and housing, Page 3-24.

Pump Tubing

Insufficient "pull" on calibrant line
Check reagent pump tubing is tensioned.
Check rubber connector is pushed firmly onto manifold.
Replace tubing, Page 3-13.

Tubing is blocked
Clear blockage, Page 3-31. If fault persists replace tubing.

Mechanical

Pump rollers are dirty
Remove pump rollers, clean, grease and re-assemble, Page 3-13.

Probe is misaligned
Realign or replace probe.

Solenoid(s) inoperative
Contact your Siemens Healthcare Diagnostics distributor.

Fluid Detector

Sample detector cover not fitted
Fit cover, Page 3-29.

Ambient light affecting fluid detector
Position 248 out of direct sunlight.

Dirty tubing
Replace probe tubing and measurement block tube, Page 3-24.

Detector failure (confirm using Sample Flow Routine, Page 4-12)
Replace detector. See instructions on detector packaging.

'Suspect Results'

Patient Results

'Suspect results' may be caused by a poorly maintained reference sensor, for example, protein build up on the reference sensor membrane, bubbles in the fill solution, or crystal growth. Under these conditions aqueous solutions (for example, QC material) diffuse across the reference sensor membrane at a different rate to non-aqueous solutions (for example, patient samples), and therefore QC results may not be affected. If the system reports patient results that are suspect include the following troubleshooting steps:

Deproteinize the sample path.
Check for air bubbles in the reference sensor, and remove.
Check for crystals in the reference sensor, and remove.
If the problem still exists after these steps have been taken replace the reference sensor cassette.

Reference Sensor

Crystals in the bottom of the sensor

Empty sensor cassette, remove crystals and refill using reference sensor fill solution.

Leaking membrane

Replace sensor cassette.

See Page 3-19.

System

Correlation factors changed

Reset to correct factors, Page 5-3.

Calibrants used for longer than 30 days

Replace Buffer Pack.

Gas pressure/gas flow rate incorrect/leaks in gas system

Check pressure and flow rate/cure leak, Page 3-10.

Incorrect gas values entered

Enter correct values, Page 5-2.

Barometric pressure incorrect/changed

Enter correct barometric pressure, Page 2-9.

Sample creep caused by blockage (e.g. fibrin clot in sample path)

Clear blockage, Page 3-31.

Bubbles in sensor fill solution

Debubble sensors, Page 3-17 and 3-19.

Sample

Sample improperly collected or stored

Follow the instructions in Sample Handling and Storage, Section 1.

QC

Problem could be caused by: abnormal pH/interfering ions/wrong matrix/ wrong assigned values/use of other aqueous standards/improper handling

Use only recommended QC materials and follow the instructions in QC Handling, Section 1. If problem persists, follow maintenance procedures.

'Suspect Results'

Capillary Samples

Small bubbles which are not detected
Take care when aspirating capillary samples.

Sample Not Detected or Sampling Fault

Pump Tubing

No "pull" on sample line
Check pump tubing is tensioned.
Check measurement block tube is connected to the pump tubing.
Replace pump tubing.

See Page 3-13.

System

No sample in measurement block
Repeat sample measurement.

Blockage in sample path
Clear blockage, Page 3-31.

Segments of Wash solution in sample path causing false 'sampling complete' or 'bubble in sample' indications
Clear blockages in drip tray/manifold/pump tubing, Page 3-31.

Leaks in sample path
Check sensor 'O' rings and replace if necessary, Pages 3-17 and 3-19.
Check sensors are seated correctly, and the sensor tensioner is pushed firmly home, Page 3-17.
Check probe connector 'O' rings and replace if necessary, Page 3-24.

Sucking in air on sample line
Cure leak.

Fluid Detector

Sample detector cover not fitted
Fit cover, Page 3-29.

Ambient light affecting fluid detector
Position 248 out of direct sunlight.

Detector failure - confirm by Sample Flow Routine, Page 4-12.
Replace detector. See instructions on detector packaging.

Dirty tube
Replace probe tubing and measurement block tube.

Printer Problems

No Printout

Printer on not selected
Select printer on in Print Options routine, Page 5-3.

Paper loaded wrong way round
Load paper correctly, Page 3-23.

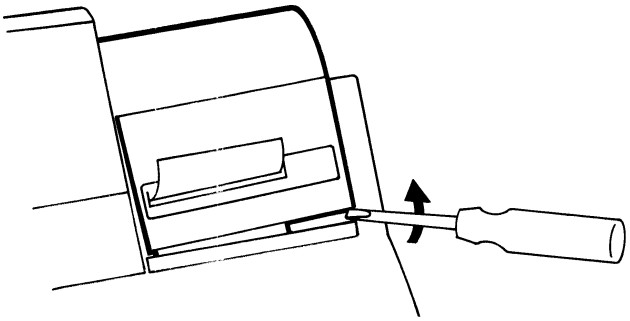
Printer failure - confirm by Roll Printer routine, Page 4-13
Contact your Siemens distributor.

Paper Jammed

Equipment: Screwdriver, supplied in Spares box.

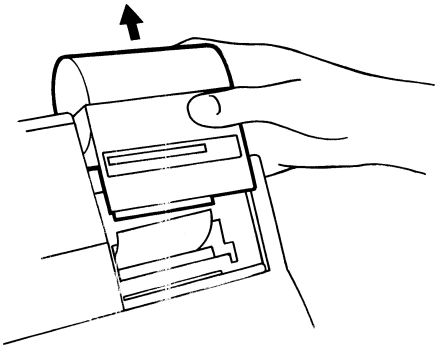
1. Tilt the paper cover backwards.
2. If the paper has jammed at the end of the roll, hold one end of the paper and rotate the paper core to free the other end. If this does not free the paper continue with step 3.
3. Lift the paper roll and cut the paper.
4. Gently try pulling the end of the paper through the tearer. If this does not free the paper continue with step 5.
5. Use the screwdriver to gently prise the paper cradle away from the front panel.

Figure 4-1. Separating the Paper Cradle From the Front Panel



6. Lift the paper cradle clear of the front panel.

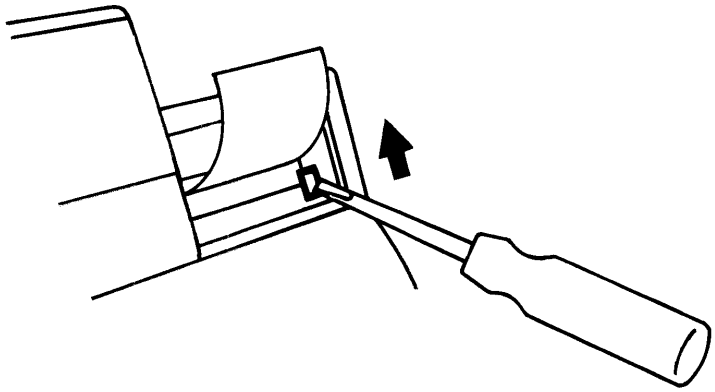
Figure 4-2. Removing the Paper Cradle



7. Gently pull the paper free. You can turn the printer mechanism wheel with the screwdriver to manually advance the paper through the mechanism.

Paper Jammed

Figure 4-3. Turning the Printer Mechanism Wheel



8. Reload the paper roll following the instructions on Page 3-23.

Hydraulic Problems

There are six solenoid valves in the 248 analyzer. Failure of any one solenoid will affect system performance.

Wash Solenoid

Failure will result in wash solution problems during a wash cycle.

Vent Solenoid

Failure will cause calibration problems on the pCO_2 and pO_2 channels.

Gas/Calibrant Select Solenoid

Selects gas or calibrant. Failure will cause problems during a calibration cycle.

Gas Select Solenoid

Selects calibration or slope gas. Failure will cause calibration problems on the pCO_2 and pO_2 channels.

pH Cal Solenoid

Delivers 7.382 buffer to the sensors. Failure will cause calibration problems on the pH channel.

pH Slope Solenoid

Delivers 6.838 buffer to the sensors. Failure will cause slope problems on the pH channel.

Heater Problems

The 248 has two heater systems, one to maintain the sensor block at 37°C, and one to preheat samples and reagents to 37°C.

Sensor Block Heater

If the sensor block temperature is outside the correct limits during sample measurement, the temperature is printed as part of the sample result. If the heater fails the display shows Heater Failed and the 248 does not allow calibrations or sample measurement.

Pre-heater

If the pre-heater fails the display shows Heater Failed and the 248 does not allow calibrations or sample measurement.

Use the Heater routine, Page 4-13, to determine which heater has failed, and contact your Siemens distributor.

Using the Troubleshooting Routines

From **Ready** press **#** for **menu** and **3** for **Troubleshooting**.

```
Main Menu → Troubleshooting

1 Measurement Block…   5 Roll Printer
2 Sample Flow
3 Heater
4 Electronics

press 1 - 5 or * to Exit
```

Measurement Block Routine

This routine measures and displays the sensor output in mV or pA. By comparing the readings to the values given you can see if the sensors require maintenance, or if they should be replaced.

NOTE: Channels that have been turned off, Page 5-5, are still measured and displayed in this routine.

1. From **Troubleshooting** press **1** for **Measurement Block**.
2. Select the buffer or gas you want to run. The 248 displays the measurement in mV/pA in addition to the normal measurement units.
3. Compare the mV/pA readings with these values*:

	7.3 Buffer pH (mV)	**6.8 Buffer pH (mV)**
Nominal mV	+300.0	+330.0
Total pull in range	200.0 to 400.0	24.5 to 38.0 above 7.3 buffer mV value
Action limits	<270.0 or >330.0	<27 or >35 above 7.3 buffer mV value

Measurement Block Routine

	Cal Gas pCO_2 (mV)	**Slope Gas pCO_2 (mV)**
Nominal mV	–170.0	–151.0
Total pull in range	-300.0 to +100.0	12.8 to 21.1 above cal gas mV value
Action limits	< -270.0 or >+80.0	<13.5 or >20.2 above cal gas mV value
	Cal Gas pO_2 (pA)	**Slope Gas pO_2 (pA)**
Nominal pA	+764.0	+80.0
Total pull in range	171 to 1961 above slope gas pA value	–100.0 to +250.0
Action limits	<300 or >1600 above slope gas pA value	<–50 or >200

Action: pH - may be caused by the reference sensor, see Pages 4-1 and 4-2. If problem persists condition or refill the pH sensor. If the problem is still apparent, replace the pH sensor.

pCO_2/pO_2 - deproteinize/replace sensor

* at 760 mmHg atmospheric pressure, using standard gases (Cal: 5% CO_2, 12% O_2 and Slope: 10% CO_2 and 0% O_2)

4. Stability – for 7.3 Buffer and Cal Gas a typical sensor will show the following performance:

	pH	**pCO_2**	**pO_2**
Noise - after 15 seconds the display will not change by more than:	0.2 mV/10 secs	1.0 mV/10 secs	2 pA/10 secs
Drift - after 15 seconds the display will not change unidirectionally by more than:	1.0 mV	5.0 mV	15 pA

during the remainder of the measurement.

Instability on the pH channel may be caused by the reference sensor. De-bubble the reference sensor and repeat the test.

5. Press ✱ to cancel the test.

Run Test Sample

1. You can use the run test sample option to:

   a. Measure a sample with a known mV value (for example, run 7.3 or 6.8 buffer as a sample).

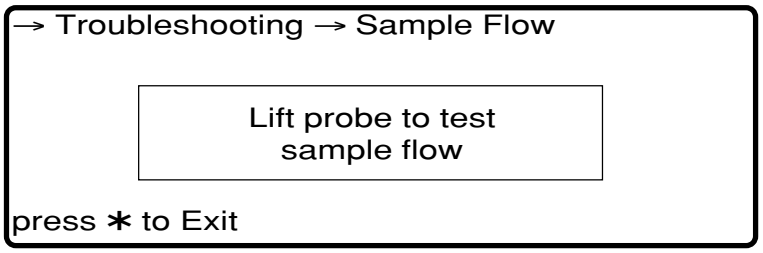
   b. Run QC samples to promote stability after installing a new sensor.

NOTE: You cannot use capillary samples with the Run Test Sample routine.

Sample Flow Routine

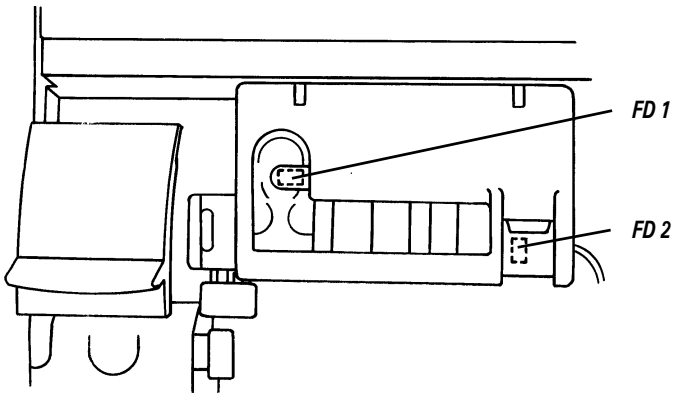
This routine checks the sample pathway from probe to waste bottle. It also checks the fluid detectors.

1. From **Ready** (or **Not Ready**) press **#** for **menu** and **3** for **Troubleshooting**. From **Troubleshooting** press **2** for **Sample Flow**.
2. Lift the probe lever.



3. Present a test sample (for example, a QC sample). To start the sampling press and hold **#** .
4. Watch the sample as it goes through the pre-heater. When the sample reaches the first fluid detector check that the FD1 box on the display changes from empty to solid.

Figure 4-4. Location of Fluid Detectors



5. Watch the sample as it goes through the measurement block. When the sample reaches the second fluid detector check that the FD2 box on the display changes from empty to solid.
6. Continue pressing **#** and remove the sample from the probe. Watch the trailing edge of the sample as it goes through the pre-heater.
7. When the trailing edge of the sample reaches the first fluid detector check that the FD1 box on the display changes from solid to empty.
8. Watch the trailing edge as it goes through the measurement block. When it reaches the second fluid detector check that the FD2 box on the display changes from solid to empty.
9. By presenting and removing the sample you can repeat the test.
10. Press * to cancel the test.
11. If either of the fluid detectors fail the test replace them following the instructions on the packaging.

Heater Routine

The Heater routine displays the system temperature, the temperature of the pre-heater and the temperature of the sensors.

1. From **Ready** (or **Not Ready)** press **#** for **menu** and **3** for **Troubleshooting**. From **Troubleshooting** press **3** for **Heater**.

   If the temperature is outside specification the 248 will display 'Warming up' or 'Heater failed'. If 'Warming up' is constantly displayed, or if 'Heater failed' is displayed contact your Siemens distributor.

Electronics Routine

The Electronics routine checks the instrument functions. The tests are:

Electronics 1 (system RAM tests)

Electronics 2 (ADC, voltage reference buffer, voltage offset DAC, motor DAC, comparitor port)

Electronics 3 (display RAM)

Heater

BP sensor

Probe

Real time clock

Fluid detectors

1. From **Ready** (or **Not Ready**) press **#** for **menu** and **3** for **Troubleshooting**. From **Troubleshooting** press **4** for **Electronics**.

When the 248 completes this routine it confirms that the testing was successful. If any of the tests fail, testing stops, and the test name is displayed with a failed message. Contact your Siemens distributor.

Roll Printer Routine

The Roll Printer routine checks the internal printer.

1. From **Ready** (or **Not Ready**) press **#** for **menu** and **3** for **Troubleshooting**. From **Troubleshooting** press **5** for **Roll Printer**.

2. The printer prints the following test set:

```
12345678901234567890123456789012
34567890123456789012345678901234
56789012345678901234567890123456
78901234567890123456789012345678
90123456789012345678901234567890
--------------------------------
```

3. If the 248 does not print the test set, check you have loaded the paper correctly, Page 3-23. If the 248 still does not print, contact your Siemens distributor.

Using the Status Indicators

There are six LEDs (Light Emitting Diodes), located behind a grille on the rear panel. These will help you diagnose faults. From left to right (viewed from the rear) these LEDs are:

LED	Check
1	microprocessor
2	–12V
3	+12V
4	–5V analog
5	+5V analog
6	+5V digital

Check that:

1. LEDs 2 to 6 are on. If any of these LEDs are off contact your Siemens distributor.
2. LED 1 is flashing. If it is not flashing:
   a. disconnect and reconnect the line cord.
   b. check the memory card is installed correctly (refer to fitting instructions).

   If LED 1 still does not flash contact your Siemens distributor.

Other Problems

Clock appears as dashes
Clock has failed. Contact your Siemens distributor.

Maintenance prompts do not appear
Prompts not set, Page 5-5.
Clock has failed.

No data shown for measured parameters, on display or printout
Parameter has not been selected, Page 5-5.

No data shown for calculated parameters, on display or printout
Maximum of 8 parameters are shown on display, but all selected parameters are printed.
Parameter has not been selected, Page 5-5.
Parameter has been selected, but appropriate measurement channels have not been selected; or ctHb and F_1O_2 are not available.

Beeper sounds during data entry
Entry field is full, and number key pressed.
Entry field is empty and **C** key pressed.
Data entered is invalid.

Atmospheric pressure cannot be changed
Entered value differs from the displayed value by more than ± 20 mmHg.
BP sensor is faulty - contact your Siemens distributor.

5 Configuring the System

The 248 can be used with the default (factory set) options and values, but there are several setup options available on the 248 which allow you to customize the 248 for your laboratory. Where applicable, we have recommended settings.

Full instructions on how to choose options and enter data is given in Section 1, *Understanding the System*. If data is entered which is outside the allowable range, or incorrect with respect to values already entered, the data entry field flashes and the value reverts to the previous value to allow you to enter the data again.

The setup options are available in 3 menus:

- Operating Setup
- System Setup
- Service Setup

When you have configured the 248, print the Setup Report, Page 5-7, so you have a record of the options selected.

Operating Setup

From **Ready** press **#** for **menu** and **5** for **Operating Setup**.

```
Main Menu → Operating Setup

1  QC Ranges…            5  Printer Options
2  Reference Ranges…     6  Correlation
3  Units
4  Calibration…

press 1 - 6 or * to Exit
```

Setting QC Ranges

QC ranges can be set for three levels of QC. (Level X has no ranges).

If a QC measurement is outside these ranges the result is flagged on the display and on the printout.

To set QC ranges: From **Ready** press **#** for **menu**, **5** for **Operating Setup** and **1** for **QC Ranges**.

Select the QC level then enter the lot number and ranges given in the QC product insert.

Maximum range that can be entered is the instrument measurement range.

Default setting: instrument measurement range.

Setting Reference Ranges

Reference ranges can be set for pH, pCO_2 and pO_2.

If a sample measurement is outside these ranges the result is flagged on the display and on the printout.

Individual reference values may vary according to a number of factors such as age, posture, diet, exercise and site of blood collection. We have taken these factors into account when establishing the default values for the 248.

Default setting:	pH	7.350 - 7.450 (35.5 - 44.7 H^+ nmol/L)
	pCO_2	35.0 - 45.0 mmHg (4.67 - 6.00 kPa)
	pO_2	80 - 100 mmHg (10.67 - 13.33 kPa)

Each laboratory should establish its own reference ranges.

To set reference ranges: from **Ready** press **#** for **menu**, **5** for **Operating Setup** and **2** for **Reference Ranges**.

Maximum range that can be entered is the instrument measurement range, Page E-1. Set the ranges to the maximum instrument measurement range if you do not want to use the reference range facility.

Choosing Units

You can choose the units of measure for parameters.

The choices are:

- pH units or H^+ nmol/L
- mmHg or kPa for gases
- g/dL, g/L or mmol/L for *c*tHb.

To choose units: from **Ready** press **#** for **menu**, **5** for **Operating Setup** and **3** for **Units**.

■ selected

□ not selected

Default setting: pH units, mmHg and g/dL.

Selecting Calibration Method and Entering Gas Values

The calibration option allows you to :

- choose how the 248 calibrates and select the maximum time interval between calibrations (see Page 1-10 for details). Siemens Healthcare Diagnostics recommends that the calibration interval is set to 30 minutes.
- enter non-Siemens gas values (see Page 3-10 for specifications of the gas).

Selecting Calibration Method and Entering Gas Values

To select calibration option: from **Ready** press **#** for **menu**, **5** for **Operating Setup** and **4** for **Calibration**.

To choose calibration method and interval press **1**.

■ selected

□ not selected

To enter gas values press **2**.

The maximum ranges available for gas values are:

cal gas	4 - 6% CO_2	10 - 14% O_2
slope gas	8 - 12% CO_2	0 - 2% O_2.

Default settings: flexible time, interval = 30 minutes.
Gas values Cal 5% CO_2, 12% O_2; Slope 10% CO_2, 0% O_2.

Setting Printer Options

The roll printer can be turned on or off, and can be set to print results only, or results and calibrations.

To set printer options: from **Ready** press **#** for **menu**, **5** for **Operating Setup** and **5** for **Printer Options**.

■ selected

□ not selected

Default setting: printer on, print results only.

Adjusting Correlation

The 248 is set during manufacture to give results which correlate with tonometered blood. If you wish to change the values to correlate with another blood gas analyzer, you must use the following procedure:

1. The correlation factors in the 248 must be reset to:
   pH, pCO_2 and pO_2 slope = 1.000
   pH, pCO_2 and pO_2 intercept = 0.000
2. Use a large sample population covering the physiological range – minimum 50 samples, preferably 100 – to generate a random distribution of values (not just normal values).
3. Make sure that the 248 and the reference analyzer are calibrated following the manufacturer's instructions, and are operating within specifications.
4. Samples should be stored iced, and measured within 30 minutes of collection. Samples should be analyzed in duplicate on both analyzers, with no more than 5 minutes between analysis on the 248 and analysis on the reference analyzer.
5. Remove outliers from the data (means of duplicates values outside ±3SD, or duplicates which differ).

Adjusting Correlation

6. Perform a linear regression analysis. We recommend the Deming method, which accounts for errors on both axes. The linear regression should be performed using a regression program on a calculator or computer. The 248 should be treated as the dependent variable (Y-axis), or the variable on the left hand side of the equation.

NOTE: The X variable should be the reference analyzer.

7. The intercept and slope values obtained can then be entered using the Correlation routine.

NOTE: Values can only be entered into the Correlation routine in pH units and mmHg. If you use H^+ nmol/L or kPa for measurement, these values must be converted into pH units and mmHg before entering.

To convert from H^+ nmol/L to pH:

$$pH = 9.0 - \log_{10}(H^+ \text{ nmol/L})$$

To convert to mmHg from kPa:

$$\text{mmHg} = \text{kPa} \times 7.50062$$

To adjust the correlation: from **Ready** press **#** for **menu**, **5** for **Operating Setup** and **6** for **Correlation**.

Default setting: pH, $p\text{CO}_2$, $p\text{O}_2$ slope = 1.000
pH, $p\text{CO}_2$, $p\text{O}_2$ intercept = 0.000

System Setup

From **Ready** press **#** for **menu** and **6** for **System Setup**.

```
Main Menu → System Setup

1  Date and Time          5  Communications
2  Maintenance Prompt     6  Security
3  Parameters             7  Print Setup Report
4  Beeper

press 1 - 7 or * to Exit
```

Changing Date and Time

The 248 shows the time and date of calibrations and measurements on the printout.

To change the date and time: from **Ready** press **#** for **menu**, **6** for **System Setup** and **1** for **Date and Time**.

Default setting: Date and time set.

Setting the Maintenance Prompts

The 248 displays prompts on the Ready screen to empty the waste bottle and to deproteinize and condition the sensors. The prompts appear at approximately 6.00 am at the intervals you select.

To set the maintenance prompts: from **Ready** press **#** for **menu**, **6** for **System Setup** and **2** for **Maintenance Prompt**.

The prompts can be set between 0 and 9 days. To cancel the prompts press **C** to clear the value or enter 0.

Default setting: empty waste bottle every day
deproteinize/condition sensors every 7 days

Selecting Parameters

You can choose parameters for measurement and for calculation.

To select parameters: from **Ready** press **#** for **menu**, **6** for **System Setup** and **3** for **Parameters**.

To select measured parameters press **1**. Choose from:

- all three channels selected
- any two of the three channels selected
- any one of the three channels selected.

■ selected

□ not selected

NOTE: The 248 will not allow you to turn off all three channels.

NOTES: Calculated parameters will only be displayed if all three measurement channels are selected.

O_2CT will only be displayed if ctHb is entered. pO_2(A-a) and pO_2(a/A) will only be displayed if F_IO_2 is entered.

To select calculated parameters press **2**. Choose from:

- HCO_3^- actual
- HCO_3^- standard
- BE(ecf) (formerly BE(vv)
- BE(B) (formerly BE(vt)
- O_2CT
- O_2 SAT
- ctCO_2
- pO_2(A-a) (formerly A-aDO_2)
- pO_2(a/A) (formerly a/A ratio).

■ selected

□ not selected

Default setting: all three measurement channels selected, no calculated parameters selected.

Changing Beeper Option

You can turn the system beeper on or off.

To change the beeper: from **Ready** press **#** for **menu**, **6** for **System Setup** and **4** for **Beeper**.

Select beeper on or off.

■ selected

□ not selected

Default settings: beeper on.

Changing Communication Options

The 248 has two data ports. You can configure both ports to your requirements. See Appendix D, *Interfacing to External Devices* for detailed information.

To configure the data output ports: from **Ready** press **#** for **menu**, **6** for **System Setup** and **5** for **Communications**.

Choose from:

- CMSI
- LIS 1
- LIS 3.

■ selected

□ not selected

Default setting: CMSI.

Setting Security

You can protect access to the Main Menu. This guards against unauthorized or accidental changing of setup options.

The security password only protects the Main Menu. The 248 will allow sample and QC measurement, and will calibrate as required.

If the security option is used, an overlay appears on the Main Menu screen prompting you to enter the password. Menu access is prevented until the password has been entered correctly. You can return to the **Ready** screen without entering the password.

To set security: from **Ready** press **#** for **menu**, **6** for **System Setup** and **6** for **Security**.

Enter a password. The password can be up to eight digits; you can use the decimal point key to insert dashes.

NOTE: If you forget the password you can use the master password (0066838).

Default setting: security off.

Printing Setup Report

If you select this option the 248 prints out all the setup options.

To print the Setup Report: from **Ready** press **#** for **menu**, **6** for **System Setup** and **7** for **Print Setup Report**.

Service Setup

From **Ready** press **#** for **menu** and **8** for **Service Setup**.

```
Main Menu → Service Setup

1  System Information
2  Language Selection



press 1 - 2 or * to Exit
```

Entering System Information

System information keeps a record of the 248 serial number, software revision and service contact telephone number.

To enter system information: from **Ready** press **#** for **menu**, **8** for **Service Setup** and **1** for **System Information**.

You can only enter the 248 serial number (4 digits) and the service telephone number (up to 12 digits). You can use the decimal point key to insert a dash.

The 248 automatically records the software revision.

Default setting: serial number entered, service contact telephone number not entered.

Changing Language

You can change the language on the 248 display and printer. The list of available languages includes:

- English
- French
- German
- Italian
- Japanese
- Polish
- Portuguese
- Russian
- Spanish

To change the language: from **Ready** press **#** for **menu**, **8** for **Service Setup** and **2** for **Language Selection**.

Default setting: English.

6 Service and Supplies

This section gives a list of supplies for the 248, the Siemens Healthcare Diagnostics addresses for obtaining service and technical information, and warranty information.

Ordering Information

Please give the following information to your Siemens distributor when ordering supplies:

1. 248 serial number
2. article number of part
3. description
4. quantity required

This will make sure your order is dealt with quickly and efficiently.

The number shown in the Quantity column is the number of items supplied against that catalog number. If the quantity is more than 1, only multiples of that number can be supplied. For a comprehensive list of service spares, see the Service Manual.

Spares

Description	Quantity	Catalog Number	Article Number
Reference electrode inner, with KCl fill solution	1	478509	09388182
Reference sensor refill, contains reference sensor cassette, KCI fill solution and ‘O’ rings	1 kit	478498	04273425
Probe and tubing kit	1 kit	673251	05738022
Probe and housing kit	1 kit	673253	06152072
Probe protectors, pack of 10	1 pack	673373	06565849
Bottle tubing kit	1 kit	673250	02660073
Sample pump tubing kit	1	673254	04282319
Reagent pump tubing kit	1	673257	05440120
Sample and reagent pump tubing kit	1	673358	09799603
Clot removal line, 0.5 m (19 1/2 inches)	1 pack	478645	07110136
Drip tray	1	673255	03521867
pH sensor plus ‘O’ ring	1	476267	07173251
pCO_2 sensor plus ‘O’ ring	1	476247	02671199
pO_2 sensor plus ‘O’ ring	1	476246	06462640
Reference sensor, contains reference sensor cassette, reference electrode inner, KCl fill solution and ‘O’ rings	1 kit	476273	05719400

Spares

Description	Quantity	Catalog Number	Article Number
Test blank sensor - ref (TB5)	1	673396000	08053446
Grounding block	1	673272	06405809
Pre-heater tube kit	1	673256	08721783
Fluid detector 1	1	673266	00659477
Fluid detector 2	1	673359	06864900
Fuse, 1A, slo-blo	2	478648	03934185
Fuse, 1A, time delay	2	478916	09991431
Voltage selector bobbin	1	478937	01652336
Fuseholder	1	478936	00119979
Power supply cord, without plug	1	001 42 498X	05357096
Power supply cord, with USA style plug	1	858 040 001	03628246
Power supply cord, with European plug	1	001 71 415A	06048720
Power supply cord, with UK plug	1	001 71 416X	06139440
Printer paper	5 rolls	673252	01150195
Ampule breakers, pack of 1000	1 pack	47860900L	09894142
Service manual	1	673259	00156483
Operator's Manual, English	1	673258	00142423
Operator's Guide, English	1	673347	03579199
Operator's Manual, French	1	—	04919031
Operator's Guide, Japanese	1	673348	04964460
Operator's Manual, Spanish	1	—	04917624
Operator's Guide, Spanish	1	673351	08107414
Operator's Manual, Italian	1	—	04917772
Operator's Guide, Polish	1	570012	04850961
Operator's Manual, Portuguese	1	—	05038802
Operator's Manual, German	1	—	04919597
248 Interface Manual	1	570030	00305144
pH/blood gas blood collection capillary tubes 100 x 100 µL capillaries	1 pack	478600	04996974
Caps for capillary tubes 478600, pack of 200	1 pack	478601	01687040
pH/blood gas blood collection capillary tubes 100 x 100 µL capillaries	1 pack	471836	08851318
Multicap blood collection kit, containing 50 x 100 µL capillary tubes	1 pack	673394	05974729
Multicap blood collection kit, containing 500 x 100 µL capillary tubes	1 pack	108758	05614986
Caps for capillary tubes 673394 and 108758, pack of 100	1 pack	478605	01558100
Caps for capillary tubes 673394 and 108758, pack of 200	1 pack	478527	08685906
Mixing kit for blood collection capillary tubes containing 1 magnet and 100 mixing fleas	1 kit	478606	04019456
Adaptors for capillaries, pack of 100	1 pack	478647	09851273

Spares

Description	Quantity	Catalog Number	Article Number
Calibration gas cylinder, 40 cu. ft. (5% CO_2, 12%O_2) (contact distributor for local equivalent)	1	001 84 146E	09361861
Cal calibration gas (5% CO_2, 12%O_2) (USA only)	1	477434000	04934960
Slope gas cylinder, 40 cu. ft. (10% CO_2, 0%O_2) (contact distributor for local equivalent)	1	001 84 147F	04464247
Slope calibration gas (10% CO_2, 0%O_2) (USA only)	1	477438000	03294747
Two stage regulator for use with above (contact distributor for local equivalent)	1	001 08 547A	05186720
Gas tubing kit, 2 metres	2 packs	473755	07140531
Interface cable, 248 to 800 ticket printer, 201 ticket printer and 270 CO-oximeter	1	673365	04993010
Interface cable, 248 to 2500 CO-oximeter	1	570011	02376472
Interface cable, 248 to DataMate™, Complement™2 and Expert datacare DMS sysems	1	673379	05047747

Reagents

Description	Quantity	Catalog Number	Article Number
6.8/7.3 Buffer Pack, contains: 4 Buffer Packs	1 pack	473496	03788731
Wash Pack, contains: 4 Wash bottles and 4 Deproteinizer/Conditioner Packs	1 pack	473497	02436114
Deproteinizer, pack of 10	1 pack	105610	08915030
Conditioner, pack of 5	1 pack	478701	02578644
Activated glutaraldehyde solution, pack of 5	1 pack	673390	03027315
pH sensor fill solution, pack of 3, plus ‘O’ ring	1 pack	478533	06386650
Reference sensor fill solution, pack of 4, plus ‘O’ ring	1 pack	478822	02563698
RapidQC Plus, Level 1, 30 x 25 mL ampules	1 pack	478941	05977442
RapidQC Plus, Level 2, 30 x 25 mL ampules	1 pack	478942	07185624
RapidQC Plus, Level 3, 30 x 25 mL ampules	1 pack	478943	01241743
Calibration Verification Material (CVM), 4 x 2.5 mL ampules each level	1 pack	473959000	09985563

Addresses

For technical assistance contact your local authorized representative.

For customer service or additional information contact your local authorized distributor.

Authorized Representative:
Siemens Healthcare Diagnostics Ltd.
Sir William Siemens Square, Frimley, Camberley, GU16 8QD, UK

Manufactured by:
Siemens Healthcare Diagnostics Inc.
Tarrytown, NY 10591-5097 USA

Siemens Healthcare Diagnostics Pty Ltd
ABN 65 007 436 651
885 Mountain Highway
Bayswater Victoria 3153
Australia

シーメンスヘルスケア・ダイアグノスティクス株式会社
東京都品川区東五反田 3ー20ー14

Siemens Healthcare Diagnostics

輸入

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Standard Instrument Warranty and Service Delivery Policy

Siemens and its authorized distributors provide customers who acquire new Siemens instruments with a one-year comprehensive, but limited, warranty. This limited warranty is designed to protect customers from the cost associated with repairing instruments that exhibit malfunctions due to defects in materials and/or workmanship during the warranty period.

Warranty Period

The warranty period commences upon installation at the customer's location and extends for a period of one year thereafter. The customer, with some exceptions, may purchase additional service coverage beyond the one year warranty period as part of the original instrument acquisition for second or subsequent years beyond the original installation date. The customer's original Purchase Invoice or appropriate Agreement Addendum must indicate the term in months for additional service coverage.

Warranty Service During Normal Hours

The customer may obtain warranty service for instruments during normal business hours by contacting the Siemens location or authorized distributor. Refer to the list of Siemens locations in this section.

Extent of a Warranty Service Call

During the warranty period, Siemens (or an authorized distributor) will repair the instrument during normal business hours, at their expense, subject to the exclusions listed below. Siemens or an authorized distributor will initiate a warranty field service call when notified. The call will be considered complete when the instrument is again operating to its published specifications and the customer, or the customer's representative, has agreed by signing the appropriate Field Service Report. When service is complete, the customer will receive a copy of the Field Service Report detailing all work performed by the Siemens representative.

Warranty Service Outside Normal Hours

Customers, with some exceptions, may also request warranty service to be delivered outside of normal business hours, including evenings, weekend days, or nationally observed holidays by contacting the Siemens location or authorized distributor. Warranty service performed at these times is subject to a surcharge unless the customer has purchased a service product option that provides warranty service outside normal hours.

Replacement of Parts

In performing warranty service under this agreement, Siemens or its authorized distributors will provide appropriate parts to repair the instrument at no charge with the exception of certain parts or subassemblies that are considered Customer Maintenance Items. Customer Maintenance Items include, but are not limited to, the following items: lamps, electrodes or sensors (which are covered by a separate warranty), Siemens reagents and calibrators, controls, pump tubing kits, paper and pens. Consult the appropriate operator's manual for a complete list of maintenance items for any specific model of instrument.

Design Changes and Retrofitting of Instruments

During the warranty period, Siemens reserves the right to change the design or construction of specific models of instruments without incurring any obligation to make such changes available to an individual instrument. If Siemens notifies customers of a change that improves the performance or reliability of their instrument, and requests to retrofit that instrument, customers must agree to allow Siemens or an authorized distributor, at Siemens expense, to retrofit components or make design changes, which will not adversely affect the instrument's performance characteristics.

Key Operator Designation

Customers will designate a key operator who will be available to Siemens representatives to describe instrument malfunctions by telephone and/or to perform simple adjustments and corrections as requested. If a key operator is not designated or is unavailable when the customer requests service, the delivery of warranty service may be delayed.

OSHA Requirements (US only)

When service is required at a customer location, the customer must provide the Siemens representative with adequate facilities that comply with the regulations of the Secretary of Labor under the Occupational Safety and Health Act (OSHA) of 1970, as amended.

Warranty Exclusions

Siemens or its authorized distributors will provide warranty service to customers during the warranty period, which includes appropriate parts, travel to the location of the instrument, and on-site labour during normal business hours. In addition, Siemens or its authorized distributors will provide warranty service during the warranty period only, and instrument repairs, labour or replacement parts, as provided during the original warranty period, will not extend the original warranty period.

Warranty Exclusions

This warranty will not apply if any of the following occurs:

1. Repairs or modifications have been made to the instrument by other than an authorized Siemens representative.
2. The instrument has been operated using other than Siemens brand accessories, or consumable supplies and/or reagents not having the same grade, quality, and composition as defined by Siemens.
3. The instrument has not been installed within 90 days of shipment to the customer's facility unless otherwise specified.
4. The customer has not performed appropriate customer maintenance procedures, as outlined in the instrument operator's manual.
5. The instrument has been misused or used for a purpose for which it was not intended.
6. The instrument has been damaged in transit to the customer or damaged by the customer while moving or relocating it without supervision by a Siemens representative.
7. Damage was caused by floods, earthquakes, tornadoes, hurricanes or other natural or man-made disasters.
8. Damage was caused by Acts of War, vandalism, sabotage, arson, or civil commotion.
9. Damage was caused by electrical surges or voltages exceeding the tolerances outlined in the instrument operator's manual.
10. Damage was caused by water from any source external to the instrument.
11. The customer has purchased an alternative agreement whose terms of warranty supersede this agreement.

Siemens or its authorized distributors will invoice customers, at current standard labour and parts rates, for instruments repaired to correct damage or malfunctions due to any of the reasons listed above.

Limitations of Siemens Original Warranty

Siemens warrants to all customers that service will be performed in a professional manner consistent with the industry. If the instrument is not performing according to its specifications, Siemens will, at its option, repair or replace the instrument. This is the customer's sole and exclusive remedy for breach of warranty.

Other than as stated above, there are no other warranties, express or implied, accompanying either the leasing of the equipment or its sale to the customer at the expiration or termination of this agreement. In addition, the warranties of merchantability and fitness for a particular purpose are disclaimed. In addition, Siemens shall not be liable for any damages caused by delay in providing repair service from any cause. Siemens liability for breach of this warranty shall be limited to the repair or replacement of defective equipment and shall not include any incidental, contingent, or consequential damages.

Appendix A Protecting Yourself From Biohazards

This appendix summarizes the established guidelines for handling laboratory biohazards. The summary is based on the guidelines developed by the National Institute of Health (NIH) and Centers for Disease Control (CDC), the guidelines for NCCLS Document M29, Protection of Laboratory Workers from Infectious Disease Transmitted by Blood and Tissue and Document I17, Protection of Laboratory Workers from Instrument Biohazards[8,9].

Use this summary for general information only. It is not intended to replace or supplement your laboratory or hospital biohazard control procedures.

By definition, a biohazardous condition is a situation involving infectious agents that are biological in nature, such as the hepatitis B virus (HBV), the human immuno-deficiency virus (HIV), or the tuberculosis bacterium. These infectious agents may be present in human blood and blood products and in other body fluids.

The major sources of contamination when handling potentially infectious agents are:

- hand-to-mouth contact
- hand-to-eye contact
- direct contact with superficial cuts, open wounds, and other skin conditions that may permit absorption into subcutaneous skin layers
- splashes or aerosol contact with skin and eyes

To prevent accidental contamination in a clinical laboratory, strictly adhere to the following procedures:

- Wear gloves while servicing parts of the instrument that have contact with body fluids such as whole blood.
- Wash your hands before going from a contaminated area to a non contaminated area, or when gloves are removed or changed.
- Perform procedures carefully to minimize aerosol formation.
- Wear facial protection when splatter or aerosol formation is possible.
- Wear protective clothing such as labcoats or aprons when working with possible biohazard contaminants.
- Keep your hands away from your face.
- Cover all superficial cuts and wounds before starting any work.
- Dispose of contaminated materials according to the biohazard control procedures established for your laboratory.
- Keep your work area disinfected.
- Disinfect tools and other items that have been near any part of the instrument sample path or waste area with 10% v/v bleach.

Appendix A Protecting Yourself From Biohazards

- Do not eat, drink, smoke, or apply cosmetics while in the laboratory.
- Do not mouth pipet any liquid, including water.
- Do not place tools or any other items in your mouth.
- Do not use the biohazard sink for personal cleaning such as rinsing coffee cups or washing hands.

To prevent needlestick injuries, needles should not be recapped, purposely bent, cut, broken or otherwise manipulated by hand.

Appendix B Precautions and Hazards

Operating Precautions

- The 248 is designed to be left connected to an a.c. supply. To prevent damage to the instrument do not leave it switched off unless the shutdown procedure (Section 3) has been followed.
- Never turn the pump rotors anticlockwise. If a bubble is detected samples should be moved forwards until there are no air bubbles beneath the sensors.
- Use Siemens Healthcare Diagnostics collection devices as the heparin coating has been specially formulated.
- Use only Siemens approved QC materials.
- Only Siemens reagents and supplies should be used with the 248 (with the possible exception of gas/regulator, Page 3-10).
  Do not use reagents after the expiry date shown on the label.
  Do not use 7.382 and 6.838 buffer for longer than 30 days once opened. Do not decant solutions from one bottle to another as this can cause contamination. Agitate the Buffer Pack daily, to incorporate any solution that may have condensed on to the inside surface of the bottles. It is advisable to empty the waste bottle daily and add approximately 10 mL of disinfectant or sodium hypochlorite to the bottle. When replacing the Buffer Pack or Wash bottle always remove the waste bottle and put the empty 7.3 Buffer or Wash bottle in its place. Siemens recommends that approximately 10 mL of disinfectant or sodium hypochlorite is put into the empty bottle before placing it in position as the new waste bottle.
- When sampling from syringes position the probe to obtain the most representative sample - do not allow probe tip to touch the syringe plunger. Obstructing the probe tip can cause sampling faults, and, in extreme cases, calibration instability.

  If you suspect the probe tip was obstructed during sampling, we recommend cancelling the sample analysis, and calibrating the 248, Page 2-9.
- Do not release the measurement block catch unless the instrument has been stopped using the **STOP SYSTEM** routine.
- Make sure that routine maintenance is carried out at the intervals stated in Section 3.
- Make sure the drip tray is always in place and is correctly connected.
- The maximum non-destructive voltage that can be applied to the data ports is ±12V d.c. to pins 3 and 8 (data receive and clear to send connections), Page D-1.

Hazards

Compressed gas cylinders require careful handling. To prevent damage and possible personal injury, observe the following precautions:

- Never drop cylinders, allow them to strike each other or subject them to other strong shocks.
- Secure cylinders to a wall or bench, or place in a cylinder base support stand.
- Never drag, roll or slide cylinders, even for short distances. Use a suitable hand truck to move cylinders.
- Never tamper with safety devices in regulators or cylinders.
- Use these gases for the calibration of clinical and research instrumentation only. US Law prohibits dispensing these gases for drug use.
- The contents are under pressure – do not puncture.
- Do not use or store near heat or open flame.
- Do not expose cylinders to temperatures above 54°C (130°F) as this may cause the contents to vent or explode.
- Never throw cylinders into fire or incinerators. Follow the disposal instructions on the cylinders.

- Take care when opening ampules. Use ampule breakers to protect your fingers.
- Do not remove the rear cover from the 248. There are no user replaceable parts within the instrument.
- All samples should be treated with the caution accorded to those known to contain pathogenic organisms. Gloves should always be worn when handling samples and waste materials.
- Make sure that before handling the component parts of the 248 (such as the probe, sensors, measurement block, pump tubing and waste bottle) you have used the **Disinfect** routine, see Section 3, *Maintaining the System*. Gloves should always be worn when carrying out any maintenance to the 248.
- Siemens Conditioner contains 0.1M ammonium bifluoride (ammonium hydrogen difluoride) which is toxic if swallowed and will cause burns if it comes into contact with the skin. In case of contact with eyes rinse immediately with plenty of water and seek expert medical advice. Clear up spillages immediately and wash with plenty of water.
- Make sure that the manufacturer's directions for use are followed when using disinfectant.
- The 248 weighs approximately 9 kg (20 lb). Observe safe lifting procedures.
- Do not move the 248 with the reagent and waste bottles in place.

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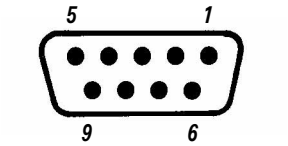
Appendix D Interfacing to External Devices

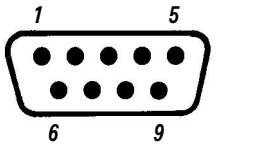
The 248 has two data ports – Port 1 and Port 2.

Figure D-1. Port 1 (Female)



Pin 1	Not used
Pin 2	Tx data (transmitted)
Pin 3	Rx data (received)
Pin 4	DTR (data terminal ready)
Pin 5	0V digital
Pin 6	Not used
Pin 7	Not used
Pin 8	CTS (clear to send)
Pin 9	Not used

Figure D-2. Port 2 (Male)



Pin 1	Not used
Pin 2	Tx data (transmitted)
Pin 3	Rx data (received)
Pin 4	DTR (data terminal ready)
Pin 5	0V digital
Pin 6	Not used
Pin 7	Not used
Pin 8	CTS (clear to send)
Pin 9	+5V digital

For full details on interfacing to external devices, refer to the 248 Interface Manual (Cat. 570030).

The 248 supports three data communication protocols on both ports.

CMSI

CMSI allows communication with Ciba Corning Diagnostics instrumentation, for example the 270 CO-oximeter, 2500 CO-oximeter and the Complement data management system. A current loop convertor is required for interfacing with some of these systems.

NOTE: When communicating with these older systems the 248 emulates a 178 blood gas analyzer. As such, QC samples are reported as syringe samples.

Data Format

Baud rate	7200
Start bit	1
Stop bits	2
Data bits	7
Parity ON	EVEN

LIS 1

LIS 1 allows communication to external printers, for example the 800 series ticket printer, or to data collection systems which accept asynchronous, unidirectional data transmission.

Data Format

Baud rate	9600
Start bit	1
Stop bit	1
Data bits	8
Parity	OFF

The transmitted data will have the same format as the data sent to the internal printer.

LIS 3

LIS 3 allows communication to Complement 2, and HIS and LIS systems.

Data Format

Baud rate	9600
Start bit	1
Stop bit	1
Data bits	8
Parity	OFF

The transmitted data will have the format and protocol defined in the 248 Interface Manual.

Connecting to a 270

Equipment: 270 interface cable (Cat. 673365).

Select CMSI on the 248.

Following the instructions in the 270 Operator's Manual, connect the 248, as a 200 series instrument, to the 270.

Connecting to Complement 2

Equipment: Complement 2 interface cable (Cat. 673379).

Select LIS 3 on the 248.

Following the instructions in the Complement 2 Manual, connect the 248.

Appendix E Specifications

Measurement Range

Measured Parameters

pH	6.001 - 8.000	(10.0 - 997.7 nmol/L H^+)
pCO_2	5.0 - 250.0 mmHg	(0.67 - 33.33 kPa)
pO_2	0.0 - 749.0 mmHg	(0.00 - 99.86 kPa)
pAtm	400 - 825 mmHg	(53.3 - 110.0 kPa)

Calculated Parameters

HCO_3^- (act and std)	0.0 - 60.0 mmol/L
BE (ecf and B)	±29.9 mmol/L
$ctCO_2$	0.0 - 60.0 mmol/L
O_2SAT	0.0 - 100.0%
O_2CT	0.0 - 40.0 mL/dL
pO_2(A-a)	0.0 - 749.0 mmHg (0.00 - 99.86 kPa)
pO_2(a/A)	0.00 - 1.00

Method Comparison

A comparison of whole blood samples run on four 248 analyzers and the Ciba Corning Model R for pH, and tonometered precision gases for pCO_2 and pO_2 was performed.

The linear regression analysis equation is y = mx + b.

C of C is the coefficient of correlation.

pH

n	Range	Equation	C of C
335	6.776 - 7.614	M248 = Model R x 1.015 - 0.107	0.995

pCO_2

n	Range	Equation	C of C
338	14.2 - 250.0	M248 = Tonometry Gas Value x 1.008 - 0.304	0.999

pO_2

n	Range	Equation	C of C
297	28.6 - 640.7	M248 = Tonometry Gas Value x 1.006 - 0.195	0.999

Precision and Recovery on Whole Blood

Whole blood was tonometered at 37°C and run on four 248 pH/Blood Gas Analyzers.

Analyte	n	WRSD	Expected	Observed	%Recovery	%CV
Level 1						
pH	15	0.008	7.502	7.491	99.9	0.10
pCO_2	15	0.435	21.3	21.7	102.0	2.00
pO_2	15	2.819	376.3	368.5	97.9	0.77
Level 2						
pH	17	0.006	7.377	7.371	99.9	0.09
pCO_2	17	0.454	35.4	35.6	100.5	1.28
pO_2	17	1.139	85.1	84.4	99.2	1.35
Level 3						
pH	20	0.008	7.300	7.299	100.0	0.11
pCO_2	20	0.522	49.6	49.0	98.7	1.07
pO_2	20	0.301	49.8	49.8	100.0	0.60
Level 4						
pH	19	0.010	7.073	7.064	99.9	0.14
pCO_2	19	2.081	99.1	98.9	99.8	2.10
pO_2	19	2.309	148.6	147.4	99.2	1.57
Level 5						
pH	19	0.007	6.972	6.972	100.0	0.10
pCO_2	19	0.737	148.6	148.5	99.9	0.50
pO_2	19	1.252	106.2	104.8	98.7	1.19

WRSD = within-run standard deviation

Precision on Controls

Data was collected from nine runs across four 248 pH/Blood Gas Analyzers over nine days.

pH

Level	n	Mean	WRSD	TotSD	%CV
1	108	7.141	0.002	0.006	0.08
2	108	7.403	0.002	0.009	0.12
3	108	7.610	0.002	0.012	0.15

Precision on Controls

pCO_2 (mmHg)

Level	n	Mean	WRSD	TotSD	%CV
1	108	73.5	0.49	2.24	3.04
2	108	45.1	0.34	0.82	1.83
3	108	23.0	0.25	0.47	2.03

pO_2 (mmHg)

Level	n	Mean	WRSD	TotSD	%CV
1	108	53.8	2.78	2.49	4.63
2	108	93.8	1.16	1.88	2.00
3	108	139.5	2.21	3.32	2.38

WRSD = within-run standard deviation

Tot SD = total standard deviation

Measurement Time

Results are displayed within 45 to 120 seconds of returning the probe (typically less than 60 seconds).

Heater

The sensor operating temperature is 37.0°C ± 0.15°C.

The pre-heater temperature is 37°C ± 1°C.

Samples

Whole blood, properly collected, refer to Page 1-7. Free from hemolysis, and if not analyzed immediately, stored as stated on Page 1-8. Fresh samples can be analyzed at a temperature of up to 40°C.

QC material, Siemens Healthcare Diagnostics recommended.

Calibration verification material, Siemens recommended.

Sample Volume

85 µL (syringe) nominal, minimum 60 µL (capillary).

Display and Printer

Display

256 x 64 pixel vacuum fluorescent display.

Printer

32 character thermal printer.

Warm Up

The 248 is designed to be connected to an a.c. supply at all times, and, when used as recommended will not require a warm-up period. However, if the analyzer must be disconnected from the a.c. supply, follow the shutdown procedure as detailed on Page 3-35.

Environmental Conditions

Operation

Temperature range	15°C to 32°C
Maximum relative humidity	85% at 32°C (non-condensing)
Barometric pressure range	400 to 825 mmHg
Maximum ambient light	8000 lux

Transportation

Temperature range	4°C to 37°C
Maximum relative humidity	95% at 37°C

Storage

Temperature range	4°C to 25°C
Maximum relative humidity	95% at 25°C

Power Requirements

Fuse rating	Two 1A fuses (time delay or slo-blo)	
Power rating	80VA	
Voltage	100V (85 to 110V) 120V (102 to 132V) 220V (187 to 242V) 240V (204 to 264V)	50/60Hz
Leakage current	<0.5mA	

Size

Width	386 mm (15 1/4 inches)
Depth	321 mm (12 5/8 inches)
Height	371 mm (14 5/8 inches)
Weight	9.1 kg (20 lb) 248 only

Reagents

Please refer to Section 6 for a complete list of reagents for use with the 248. Solutions should be stored at 4 to 25°C away from direct sunlight.

Appendix F Installation

Your 248 pH/Blood Gas Analyzer should be installed by an authorized Siemens Healthcare Diagnostics representative.

Environmental Specifications

The 248 requires the following location:

248 Dimensions

Width: 386 mm (15 1/4 inches)

Depth: 321 mm (12 5/8 inches)

Height: 371 mm (14 5/8 inches)

Weight: 9.1 kg (20 lb)

Power Requirements

100V (85 to 110V)

120V (102 to 132V) 50/60Hz

220V (187 to 242V)

240V (204 to 264V)

NOTE: If you have a 230V supply, use the 240V setting on the voltage selector bobbin.

Power Rating 80VA

Leakage current <0.5mA

Ambient Operating Temperature	15 - 32°C
Ambient Operating Relative Humidity	5 - 85%, non-condensing
Ambient Light	8000 lux maximum
Ambient Operating Barometric Pressure	400 - 825 mmHg

The 248 should be placed on a level surface and not be exposed to direct sunlight. Clear access to the rear panel power connector should be available.

Installation Procedure

Use the following procedure to install your 248 only if you are located in a region where Siemens Field Service Representatives do not perform installation.

For detailed information on the operating system, refer to Section 1, *Understanding the System*, and Section 2, *Operating the System*. Refer to Section 3, *Maintaining the System*, for figures.

1. Inspect the packing case and report any damage to the shipper. Notify your Siemens representative at installation.
2. Unpack the accessories and check against the following list:

Cat	Description	Qty
473755	Gas Tubing Kit	2
673252	Printer Paper, 5 rolls	2 packs
473496	Buffer Pack	1
473497	Wash/CD Pack	1
476267	pH Sensor	1
476247	pCO_2 Sensor	1
476246	pO_2 Sensor	1
476273	Reference Sensor	1
	Power Supply Cord	1

3. The Spares box contains the following items

	Description	Qty
	Clot removal line	1 pack
	Fuse, 1A, time delay	2
OR	Fuse, 1A, slo-blo	2
	'O' rings	2
	Probe and tubing	1
	Screwdriver	1
	Grounding block	1
	Voltage selector bobbin	1
	Probe protectors	3
	Pump roller	1
	Pump roller drive pin	1
	Grease	1 vial
	Sample detector cover	1
	Sample detector cover screw	1
	Bottle tubing connector	2

WARNING The 248 weighs approximately 9 kg (20 lb). Observe safe lifting procedures.

4. Remove the 248 from the shipper and place on the work surface, with the rear panel accessible.
5. Select the voltage required for your power supply, and slide the voltage selector bobbin (from the Spares box) into the voltage selector so that the selected voltage is visible when the voltage selector cover is closed.
6. If necessary, connect a suitable plug to the power supply cord. Follow the plug manufacturer's instructions.
7. Insert the power supply cord into the power connector on the rear panel.

CAUTION: Do not connect the power supply cord to the power supply.

Installing the pH, pCO_2 and pO_2 Sensors

1. Check the level of solution in the pH sensor. It should be full, with a small air space at the top.

   If necessary, empty and refill using pH sensor fill solution. Follow the instructions on the fill solution pack. Make sure there are no air bubbles trapped in the bottom of the sensor.

   NOTE: The gas sensors are sealed and cannot be refilled. Tap them to release any trapped air bubbles before installation.

2. Raise the front cover. Slide the measurement block catch down and raise the block cover.

3. Insert the sensors in the following order:

   pO_2 pCO_2 grounding block pH

   NOTE: The grounding block is in the Spares box.

   Slide the sensors into place, making sure that the sensor contacts align with the contacts in the block.

Installing the Reference Sensor

1. Refer to the reference sensor package insert for filling instructions.

   It is particularly important to make sure there are no air bubbles trapped in the left chamber of the sensor cassette immediately above the sample pathway. Do not overfill the righthand reservoir chamber.

2. Swing the block tensioner to the right and insert the reference sensor from the side. Push the bottom of the sensor to click it into place. Make sure all the sensors are seated correctly, then push the tensioner firmly home to make a good seal. Lower the block cover, snapping it into place.

Connecting the Pump Tubing

1. Tension the sample pump tubes (lefthand pump) by pulling the tube lugs under the tensioners.

2. Connect the sample tube to the measurement block tube, and the waste tube to the manifold.

3. Connect the rubber connector to the manifold.

4. Tension the reagent pump tubes (righthand pump) by pulling the tube lugs under the tensioners.

5. Connect the rubber waste cap connector to the manifold.

6. Make sure there are no kinks in the pump tubing.

7. Date the pump tubing labels a maximum of three months ahead.

Installing the Reagents

1. Remove the caps from the 6.8 and 7.3 bottles.
2. Insert the tubing connectors into the bottles and push the caps onto the bottles.
3. Place the bottle assembly in the lefthand side of the reagent compartment feeding the tubes through the caps into the solutions.
4. Date the buffer pack label a maximum of 30 days ahead.
5. Remove the CD pack from the neck of a wash bottle. Remove the bottle cap.
6. Insert the tubing connectors into the bottle and push the cap onto the bottle.
7. Place the bottle to the right of the buffer bottles feeding the tube through the cap into the solution.
8. Check that the waste bottle is in position.
9. Check that the neck of the waste bottle is positioned underneath the rubber cap. The waste cap spout should be inside the neck of the waste bottle.

Installing the Gas Cylinders

⚠ **CAUTION**: The instructions given are for Siemens gas cylinders and regulators and we recommend the use of these at all times. If you use other cylinders and regulators they must meet the following specfication:

- Only certified value gas cylinders should be used.

  For calibration gas the value should be 5% CO_2 (acceptable range 4 to 6%) and 12% O_2 (acceptable range 10 to 14%), balance N_2.

  For slope gas the value should be 10% CO_2 (acceptable range 8 to 12%) and 0% O_2 (acceptable range 0 to 2%), balance N_2.

  The gas values used must be entered (see Page 5-2, *Entering Gas Values*).

- The regulator must have a low diffusion diaphragm to prevent selective diffusion and alteration of the gas values. All fittings must be leak free. The regulator must have a low flow precision needle valve for gas flow adjustment and supply 4 ± 1 psi at a flow of up to 20 cc/minute. When the needle valve is closed the output psi must not rise by more than 2 psi compared to the 'open' output.
- The tubing used must not allow selective diffusion of CO_2, O_2 or N_2. Siemens tubing is designed to maximize through-flow rates, reducing the diffusion rates. The accuracy of the 248 is adversely affected by the use of diffusive tubing.
- Siemens assumes no liability for performance when non-standard equipment is used.

Installing the Gas Cylinders

WARNING Compressed gas cylinders require careful handling. To prevent damage and possible personal injury, observe the following precautions:

Compressed gas cylinders require careful handling. To prevent damage and possible personal injury, observe the following precautions:

- Never drop cylinders, allow them to strike each other or subject them to other strong shocks.
- Secure cylinders to a wall or bench, or place in a cylinder base support stand.
- Never drag, roll or slide cylinders, even for short distances. Use a suitable hand truck to move cylinders.
- Never tamper with safety devices in regulators or cylinders.
- Use these gases for the calibration of clinical and research instrumentation only. US Law prohibits dispensing these gases for drug use.
- The contents are under pressure – do not puncture.
- Do not use or store near heat or open flame.
- Do not expose cylinders to temperatures above 54°C (130°F) as this may cause the contents to vent or explode.
- Never throw cylinders into fire or incinerators. Follow the disposal instructions on the cylinders.

1. Place the gas cylinders into their final position and secure.
2. Remove the plastic protective wrapping from the valve assemblies.
3. Fit the gas cylinder seals on the regulators.
4. Attach the gas regulators to the cylinders with the regulator nipple engaging the opening in the cylinder valve.
5. Attach and tighten the yoke screws firmly.
6. Attach and tighten the tubing adapter fitting into the needle valves.
7. Connect one end of the lengths of cylinder connecting tubing to the regulator fittings.
8. Slowly open the cylinder valves until the pressure gauge indicator stops rising (approximately 3/4 of a turn, average psi is 2000 - minimum working pressure is 300 psi). Open the cylinder valves one more turn.

CAUTION: The needle valve is easily damaged. Turn the valve gently when opening.

9. Open the needle valve fully and allow the gas to flow for a few seconds.
10. Connect the tubing from the calibration gas cylinder to the cal gas connector tubing on the rear of the 248. Connect the tubing from the slope gas cylinder to the slope gas connector tubing on the rear of the 248. Make sure there are no kinks or other restrictions in the lines.
11. Listen carefully for any gas leakage. Use soapy water to check for bubbles.
12. Check that the regulator outlet gauges read 4 ± 1 psi.
13. Lower the front cover.

Powering-Up the 248

1. Connect the power supply cord to the power supply. The 248 begins the power-up sequence:
   a. The 248 checks the RAM, ADC, voltage reference buffer, voltage offset DAC, motor DACs, comparitor port, RTC, battery backed RAM, probe, printer hardware and fluid detectors and then displays **Warming Up**.
2. While the 248 is warming up you can:
   a. Prime the 248 to remove bubbles from the calibrant lines:
      1. Press **#** for **menu**, **2** for **Maintenance** and **3** for **Prime**.
      2. If necessary, repeat the routine to thoroughly prime the system.
   b. Condition the sensors:
      1. From **Maintenance** press **2** for **Condition**.
   c. Initiate a 2-point calibration:
      1. From **Maintenance** press **1** for **Calibration** and **2** for **Full 2 Point**. The data from this calibration will not be used.
   d. Configure the 248:
      1. Refer to Section 5, *Configuring the System*.
3. When the 248 reaches operating temperature it will carry out two full 2 point calibrations 10 minutes apart.
4. When the 248 displays **Ready** perform the appropriate quality control procedures.
5. Your 248 installation is complete.

Appendix G Operating Principles

The 248 measurement technology is based on electrochemistry. Electrochemistry is the measurement of current, or voltage, occurring in an electrochemical cell, between a chemical and an electrical system.

Each electrode, or sensor, is designed to selectively measure the activity of a specific substance. Many elements in a sample may interact with a sensor, but the sensor is highly selective for one substance over others.

The potential generated at the sensor is converted into an electronic signal by a transducer mechanism. The 248 uses potentiometry and amperometry. Potentiometry measures the potential that develops at the sensor. Amperometry involves applying a voltage to the sensor and then measuring the current generated.

The electronic signal is filtered and smoothed, and converted into a concentration measurement expressed in standard units.

Potentiometry

During sample analysis, a potential develops at the sensor as a result of the interaction with the analyte (ion). The potential is related to the amount of analyte in the sample.

The reference sensor provides a fixed potential, which is independent of analyte activity, and is used to compare the measured potential.

The sensor potential corresponds to the analyte activity, and is directly related of the concentration of the analyte in solution. The potential is expressed by the Nernst equation:

$$E_{cell} = K + (2.3RT/ZF) \log a_i$$

where:
- E_{cell} = electrochemical cell potential
- K = a constant (produced by various sources such as the liquid junction)
- R = gas constant
- T = absolute temperature
- Z = ionic charge
- F = Faraday's constant
- a_i = activity of the ion in the sample

This equation shows that the potential is logarithmically related to the activity of the analyte in the sample.

However, the sensor actually measures the activity of the analyte in solution. In clinical chemistry results are typically expressed as concentration rather than activity. The activity of an ion is equivalent to the concentration (mol/L) multiplied by the activity coefficient (the degree with which the ion interacts with other ions in solution). The activity coefficient depends on the ionic strength of the solution, and generally decreases with increasing ionic strength[10].

Potentiometry

Using an established convention, the activity of ions as measured by the sensors can be expressed as concentration. Ionic strength is the primary variable affecting the activity coefficient of ions in solution. The normal ionic strength of blood plasma water is 160 mmol/kg[11]. Controlling the ionic strength of calibrating solutions to 160 mmol/kg sets the activity coefficients of ionic species in the calibrations equal to those of blood plasma water at ionic strengths close to normal. Both calibrations and measurements may then be expressed in units of concentration rather than activity.

Amperometry

Amperometry is an electrochemical technique used to determine the amount of analyte in solution by applying a fixed voltage between two electrodes in an electrochemical cell, then measuring the current flowing.

The measuring electrode is negatively charged and serves as a cathode in the electrical system. The reference electrode is positively charged, and serves as the anode. Both electrodes are attached to an external voltage source.

As the sample comes into contact with the two electrodes, a known voltage is applied to the cathode. This voltage attracts molecules from the analyte in solution to the cathode causing a chemical reaction (reduction) that uses electrons. The electrons are replaced immediately in the sample solution by a separate reaction (oxidation) that takes place at the anode. The two reactions result in a current flow that can be measured. The current measured is directly proportional to the concentration of analyte (reacting at the cathode) present in the sample.

Sensors

Reference Sensor

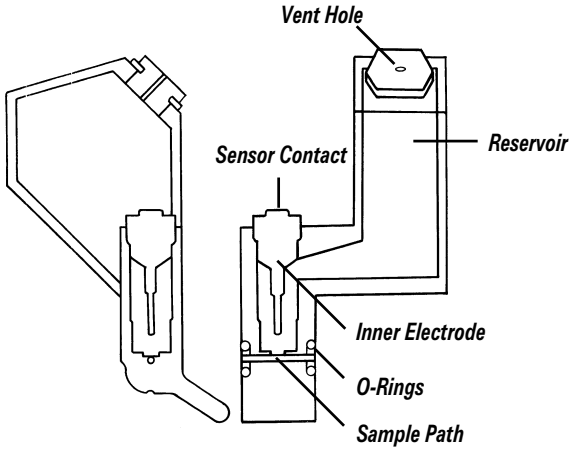
The reference sensor contains a silver (Ag) wire, coated with layer of silver chloride (AgCl) surrounded by a saturated potassium chloride (KCl) solution. By making sure that the concentration of chloride ions (Cl^-) remains unchanged in the solution, the reference sensor maintains a constant electrical potential. KCl is added to the reference sensor solution chamber to maintain a saturated solution of KCl at 37°C.

A permeable cellulose membrane separates the KCl solution from the sample. During analysis a diffusion potential, created between the sample and KCl solution, provides the fixed half-cell potential required for measurement.

The Ag wire conducts the potential to the measurement device where it is compared to the potential of the measuring sensor. The potential difference measured reflects the concentration of analyte in the sample.

Reference Sensor

Figure G-1. Reference sensor (cutaway view)

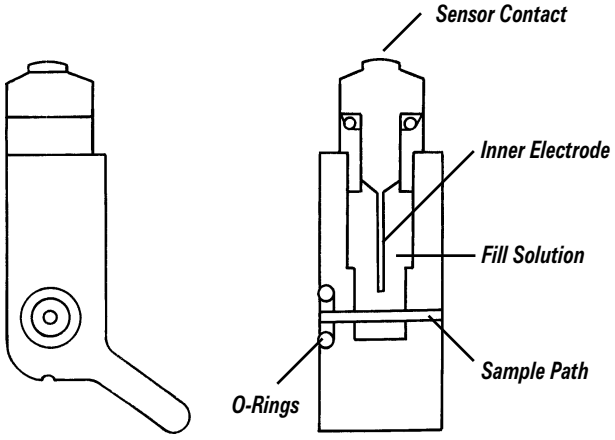


pH Sensor

The pH sensor is based on ion selective electrode (ISE) technology and is a half-cell that forms a complete cell with the external reference sensor. It contains a silver/silver chloride wire (Ag/AgCl) surrounded by a buffer solution of fixed hydrogen ion concentration. A glass membrane, highly sensitive and specific for hydrogen ions, separates the sample from the solution.

As the sample comes into contact with the membrane of the pH sensor, a potential develops due to the exchange of hydrogen ions in the membrane. The silver/silver chloride wire conducts the potential to a voltmeter where it is compared to the constant potential of the reference sensor. The final measured potential reflects the hydrogen ion concentration of the sample, and is used to calculate the pH value.

Figure G-2. pH sensor (cutaway view)



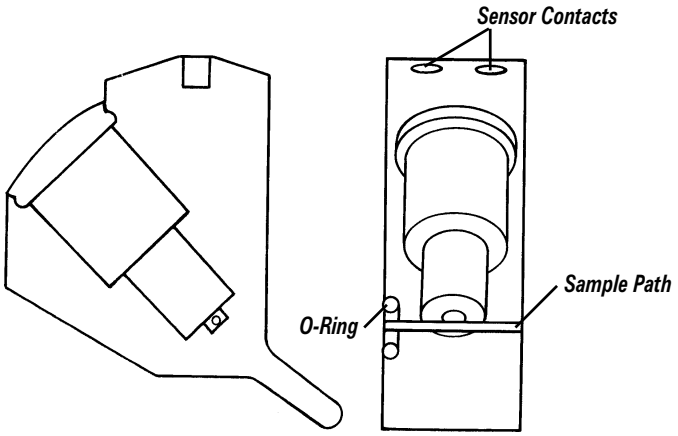
pCO_2 Sensor

The pCO_2 sensor is based on the electrode described by Severinghaus and Bradley[12] and consists of a measuring electrode and an internal reference electrode. The measuring electrode, which is a pH electrode, is surrounded by a chloride-bicarbonate solution. A membrane permeable to gaseous CO_2 separates this solution from the sample. The internal reference electrode contains a silver/silver chloride electrode surrounded by the chloride-bicarbonate solution, and provides a fixed potential.

As the sample comes into contact with the membrane, CO_2 diffuses into the chloride-bicarbonate solution causing a change in the hydrogen ion concentration.

The internal pH electrode generates a potential which is compared to the fixed potential of the internal reference electrode. This results in a measurement that reflects pH change in the chloride-bicarbonate solution. The change in pH is proportional to the log of the partial pressure of pCO_2.

Figure G-3. pCO_2 sensor (cutaway view)



pO_2 Sensor

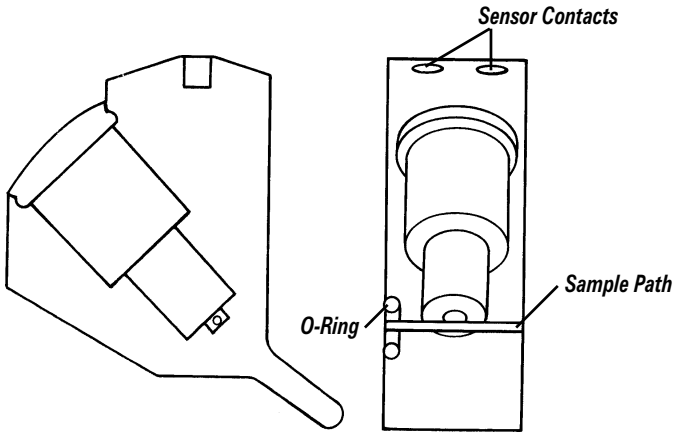
The pO_2 sensor is based on the electrode described by Clark[13] and uses amperometric technology. The sensor consists of a platinum (Pt) cathode, a silver (Ag) anode, an electrolyte solution and a gas permeable membrane.

A constant voltage, called a polarizing voltage, is maintained between the anode and the cathode. As dissolved oxygen from the sample passes through the membrane into the electrolyte solution it is reduced at the cathode. The circuit is completed at the anode, where the Ag is oxidised.

The amount of oxygen reduced is directly proportional to the number of electrons gained at the cathode. Therefore, by measuring the change in current (electron flow) between the anode and the cathode, the amount of oxygen in the sample can be determined[14].

pO_2 Sensor

Figure G-4. pO2 sensor (cutaway view)



Measuring pH and Blood Gases

pH

pH expresses the hydrogen ion activity in a solution as the negative logarithm of the hydrogen ion concentration:

$$pH = -\log cH^+$$

where cH^+ is the molar concentration of hydrogen ions.

The hydrogen ion is the determinant of the acidity of blood or plasma. Normal cellular metabolism requires an exacting environment where hydrogen ion concentration must be maintained within narrow limits. Hydrogen ion activity reflects the acid-base balance within blood. Acids donate hydrogen ions; bases remove hydrogen ions. The lungs, kidneys and blood all work to maintain the acid-base status within the strict limits necessary.

The Henderson-Hasselbalch equation describes how pH expresses the interaction of acid and base in blood:

$$pH = pK + \log\frac{base}{acid}$$

where K is the dissociation constant, which describes the ability of a solution to release hydrogen ions. Since K, and therefore pK, is a constant, this equation can be used to demonstrate that pH is proportional to the acid-base concentrations in blood.

pH is clinically significant as a means to determine acid-base disturbances. Acid-base disorders can result in several pathological conditions. An acid-base disorder resulting initially from ventilatory dysfunction is called a primary respiratory acidosis or alkalosis, while one due to renal or gastrointestinal inadequacy is referred to as metabolic acidosis or alkalosis. Using acceptable therapeutic ranges, a pH less than 7.3 indicates acidosis, and a pH greater than 7.5 indicates alkalosis[15].

pCO_2

Carbon dioxide (CO_2) is produced during normal cell metabolism and is released into the blood stream where it is transported to the kidneys and lungs for excretion. CO_2 is transported through the blood as bicarbonate (HCO_3^-), dissolved CO_2, and carbonic acid (H_2CO_3).

The levels of HCO_3^-, H_2CO_3, and dissolved CO_2 play a major role in maintaining the pH in blood. pH is proportional to the acid-base relationship.

Although other acids and bases are present in the blood, the H_2CO_3/HCO_3^- relationship is sensitive and dynamic and typically reflects other acid-base changes.

When the measurement of the partial pressure of carbon dioxide (pCO_2) in the blood is combined with the measured pH, the values can be incorporated into the Henderson-Hasselbalch equation to determine the HCO_3^- in addition to the ctO_2. Since the pCO_2 value is proportional to the content of dissolved CO_2/HCO_3^-, the value for pCO_2 can be used with pH not only to calculate HCO_3^-, but also to aid in the differentiation of acid-base abnormalities.

The measurement of pCO_2 is essential in determining ventilatory status. Because the lungs are primarily responsible for controlling pCO_2 levels, changes in pCO_2 reflect respiratory status. For example, an increase in CO_2 indicates decreased ventilation as CO_2 is retained, and a decrease in CO_2 indicates increased ventilation (hyperventilation) as CO_2 is expired from the lungs.

Together, pH and pCO_2 provide a more definitive diagnostic tool in assessing respiratory function. An increase in the pCO_2 value and a decrease in pH indicates respiratory acidosis - a condition where CO_2 is retained by the lungs. A decrease in the pCO_2 value and an increase in pH indicates respiratory alkalosis - a condition where the lungs are expiring too much CO_2 relative to the amount produced.

pO_2

Oxygen (O_2) is essential for cell and tissue metabolism in the body. The cardiopulmonary system is responsible for transporting oxygen to the cells. Oxygen transport involves four major steps: convection and diffusion from the air into the pulmonary circulation, combination of O_2 from the lungs with haemoglobin in red blood cells, transportation of the O_2 through the arteries to the cell, and finally the release into the tissues and utilization of O_2 at cellular level.

Since it is not possible to measure intra-cellular oxygen tension, arterial pO_2 has become a standard for clinical evaluation of arterial oxygenation status. pO_2(A) measurement, which indicates the oxygen tension in arterial blood, reflects the pressure or driving force for moving oxygen from one location to the next due to pressure differential. Although not a measurement of the O_2 content, this provides a measurement tool to evaluate the pulmonary gas exchange efficiency from an arterial blood sample.

pO_2

Complete laboratory evaluation of oxygenation requires much more than simple blood gas measurements. Assessment of ventilatory system and acid-base status is essential to properly interpret clinical significance of arterial oxygenation status. However, many patients can be evaluated and treated successfully using blood gases alone if clinical observations and patient history are taken into account[14].

The measurement of pO_2 is significant in evaluating the degree of hypoxemia (a deficiency of O_2 in arterial blood) present in a patient.

Calculated Parameters

The 248 calculates other parameters of interest to clinicians, and uses several different equations to provide these parameters. Unless otherwise noted, all measured values used in equations are at 37°C.

Bicarbonate Ion (HCO_3^-)

Bicarbonate (HCO_3^-) is the major buffer substance present in the body, and plays a major role in maintaining the pH level in blood. It is present in large amounts in the blood as a result of the dynamic state of CO_2 in the blood. The majority of CO_2 is transported as HCO_3^-.

The kidneys are the major controller of bicarbonate ion. Bicarbonate levels are clinically significant in helping to determine the non-respiratory, renal (metabolic) component in acid-base disorders.

Changes in HCO_3^- levels along with pH values can help determine if acidosis or alkalosis disorders are of metabolic origin. In metabolic acidosis, HCO_3^- levels decrease causing an increase in H^+ which leads to a decrease in pH. Conversely, in metabolic alkalosis, HCO_3^- levels increase, causing a decrease in H^+ which leads to an increase in pH.

There are two versions of bicarbonate, the actual value and the standard value, available in the System Set Up menu.

Actual Bicarbonate (HCO_3^- act)

Based on the National Committee for Clinical Laboratory Standards (NCCLS) recommendations[16]

$$c\mathrm{HCO_3^-}_{act} = 0.0307 \times p\mathrm{CO_2} \times 10^{(\mathrm{pH} - 6.105)}$$

Standard Bicarbonate (HCO_3^- std)

The equation described by VanSlyke and Cullin[17] is used for calculating standard bicarbonate

$$c\mathrm{HCO_3^-}_{std} = 24.5 + 0.9A + (A–2.9)^2\ (2.65 + 0.31c\mathrm{tHb})/1000$$

where $A = BE(B) – (0.2c\mathrm{tHb}(100–\mathrm{O_2SAT})/100)$

If no ctHb value has been entered, a value of 15g/dL is assumed.

Base Excess

Base excess is an empirical expression that approximates the amount of acid or base required to titrate one litre of blood back to a normal pH of 7.4. The base excess in blood with a pH of 7.4, pCO_2 of 40 mm Hg (5.33 KPa), total haemoglobin of 15 g/dL and a temperature of 37°C is zero. Base excess is useful in the management of patients with acid-base disorders as it allows the estimation of the number of equivalents of sodium bicarbonate or ammonium chloride required to correct the patient's pH to normal.

There are two versions of base excess, available in the System Set Up menu.

Base Excess of Extracellular Fluid (BE(ecf))

The base excess of extracellular fluid, formerly known as *in vivo* base excess, reflects only the non-respiratory component of pH disturbances

$$BE(ecf) = cHCO_{3^{-}act} - 24.8 + 16.2\ (pH - 7.4)$$

Base Excess of Blood (BE(B))

The base excess of blood, formerly known as *in vitro* base excess, is calculated from the following equation

$$BE(B) = (1 - 0.014ctHb)\ (cHCO_{3^{-}act} - 24.8 + (1.43ctHb + 7.7)\ (pH - 7.4))$$

If no *c*tHb value has been entered, a value of 15g/dL is assumed.

Oxygen Content (O_2CT)

Oxygen content is the concentration of the total oxygen carried by the blood, including oxygen bound to haemoglobin as well as oxygen dissolved in plasma and in the fluid within red cells.

Oxygen content is calculated, using NCCLS recommendations[18], as follows:

$$O_2CT = (1.39ctHb \times O_2SAT/100) + (0.00314pO_2)$$

where *c*tHb is expressed in g/dL.

If no *c*tHb value has been entered, O_2CT is not calculated.

Clinically, dissolved oxygen is for most situations analytically unimportant. However, at very low levels of haemoglobin or in patients receiving hyperbaric oxygen therapy, dissolved oxygen may be a very significant contributor to oxygen transport.

Oxygen Saturation (Estimated)

Oxygen saturation (O_2 SAT) is a ratio, expressed as a percentage of the volume of oxygen carried to the maximum volume that can be carried. Knowledge of oxygen saturation is useful for predicting the amount of oxygen actually available for the tissues and can be used to determine the effectiveness of oxygen therapy.

NOTE: Clinically significant errors can result from incorporating an estimated O_2SAT value in further calculations, such as shunt fraction (Qsp/Qt), or by assuming that the value obtained is equivalent to fractional oxyhaemoglobin[18].

$$O_2SAT = \frac{N^4 - 15N^3 + 2045N^2 + 2000N}{N^4 - 15N^3 + 2400N^2 - 31{,}100N + (2.4 \times 10^6)} \times 100$$

where $N = pO_2 \times 10^{[0.48(pH-7.4) - 0.0013\ BE(B)]}$

Because oxygen saturation also depends on the level of carbon monoxide and 2,3 diphosphoglycerate (2, 3 DPG) in the blood, the calculated value for oxygen saturation may not be equal to that actually measured for patients showing abnormal levels of 2, 3 DPG or carbon monoxide. The equation does not account for these variations, therefore the oxygen saturation that is reported should only be used as an estimate of the actual value.

Total Carbon Dioxide ($ctCO_2$)

Total carbon dioxide ($ctCO_2$), in combination with pH and pCO_2, is useful in distinguishing between metabolic and respiratory acid-base disorders.

Carbon dioxide exists in several forms in blood plasma, but only two forms, dissolved CO_2 and HCO_3^- are quantitatively significant. Based on NCCLS recommendations[16], the following equation is used:

$$ctCO_2 = cHCO_{3\,act}^- + (0.0307 \times pCO_2)$$

Patient Temperature Correction

All measurements and calculations are based on a standard temperature of 37°C. Actual patient temperature values can be entered during sample analysis which allows the 248 to provide temperature corrected results. The following equations, based on NCCLS recommendations[16], are used:

$$pH(T) = pH - (0.0147 - 0.0065 \times (7.4 - pH)) \times (T - 37)$$

$$pCO_2(T) = pCO_2 \times 10^{(0.019 \times (T - 37))}$$

$$pO_2(T) = pO_2 \times 10^{(A \times (T - 37))}$$

$$\text{where } A = \frac{5.49 \times 10^{-11} \times pO_2^{3.88} + 0.071}{9.72 \times 10^{-9} \times pO_2^{3.88} + 2.3}$$

and where T = 37°C if not entered.

Gas Exchange Indices

Gas exchange indices are a quick way to estimate the relationship between pulmonary dysfunction and hypoxia, and to quantitatively determine the degree of pulmonary shunting. However, they do not have a high level of correlation with the actual measurement of arterial and mixed venous blood and should be used with discretion. The gas exchange indices are provided for convenience. Final judgment of their use is in the hands of the physician. The gas exchange indices require an arterial sample and use measured values at patient temperature.

Alveolar O_2

Alveolar O_2, referred to as $pO_2(A)$ or p_AO_2, is the partial pressure of oxygen in alveolar gas. It is a primary component in the detection of gas exchange indices. The following equation[14,19] is used to estimate the alveolar O_2:

$$pO_2(A)(T) = F_IO_2/100 \text{ x } (p\text{Atm} - pH_2O) - pCO_2(T) \text{ x } (1.25 - 0.25 \text{ x } F_IO_2/100)$$

where T = patient temperature (°C)

$$pH_2O = 10^{(0.0244 \text{ x } T + 0.7655)} + 0.4$$

Arterial-Alveolar Oxygen Tension Difference

The arterial-alveolar oxygen tension difference ($pO_2(A–a)$), (or $A–aDO_2$) is useful as an index of gas exchange within the lungs if ctO_2 measurements are not available. The following equation[14,19] is used:

$$pO_2(A–a)(T) = pO_2(A)(T) - pO_2(a)(T)$$

where $pO_2(A)(T)$ is the temperature corrected oxygen tension of alveolar gas, and $pO_2(a)(T)$ is the temperature corrected oxygen tension of arterial blood.

Arterial-Alveolar Oxygen Tension Ratio

The arterial-alveolar oxygen tension ratio ($pO_2(a/A)$), (or a/A ratio) provides an index of oxygenation that remains relatively stable when F_IO_2 changes. It is useful in predicting oxygen tension in alveolar gas. The following equation[20] is used:

$$pO_2(a/A)(T) = \frac{pO_2(a)(T)}{pO_2(A)(T)}$$

where $pO_2(A)(T)$ is the temperature corrected oxygen tension of alveolar gas, and $pO_2(a)(T)$ is the temperature corrected oxygen tension of arterial blood.

NOTE: If F_IO_2 value is not entered, the gas exchange indices will not be calculated.

The algorithms used for *Calculated Parameters* are those currently recommended by NCCLS. Algorithms used in our earlier instruments are given here for reference:

Actual Bicarbonate (HCO_3^-act)

$HCO_{3^-act} = 0.031 \times pCO_2 \times 10^{(pH - 6.1)}$

Standard Bicarbonate (HCO_3^-std)

No change

Base Excess of Extracellular Fluid (BE(ecf))

Formerly BE(vv)

$BE(ecf) = (1 - 0.004ctHb) \times (HCO_{3^-act} - 24) + (9 + 0.3ctHb) \times (pH - 7.4) - 0.3ctHb \times (100 - O_2SAT)/100$

Base Excess of Blood (BE(B))

Formerly BE(vt)

$BE(B) = (1 - 0.014ctHb) \times (HCO_{3^-act} - 24) + (9.5 + 1.63ctHb) \times (pH - 7.4)$

Oxygen Content (O_2CT)

$O_2CT = 1.39ctHb \times O_2SAT/100 + 0.003\ pO2$

Oxygen Saturation (Estimated)

No change

Total Carbon Dioxide ($ctCO_2$)

$ctCO_2 = 0.031pCO_2 + HCO_{3^-act}$

Patient Temperature Correction

$pH(T) = pH - 0.015 \times (T - 37)$

pCO_2 no change

$pO_2(T) = pO_2 \times 10^{(A \times (T - 37))}$

where $A = 0.0052 + 0.027 \times (1 - 10^{(-0.13 \times (100 - O_2SAT))})$

Arterial-Alveolar Oxygen Tension Difference

No change

Arterial-Alveolar Oxygen Tension Ratio

No change