



# Ambulatory Blood Pressure Monitor

90207/90207Q  
Service Manual

070-0189-02 Rev. F

*more time to care*



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# Introduction

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## Overview

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The Spacelabs Medical Model 90207 Ambulatory Blood Pressure (ABP) Monitor is a small, lightweight unit designed to take blood pressure and heart rate measurements for a 24- or 48-hour period. These measurements are recorded in the monitor and transmitted to a Spacelabs Medical ABP analysis system for report generation. Several analysis systems are available. Refer to your specific analysis system manual for more information.

**Note:**

*Beginning with August 2004 shipments, all 90207 models have a “Q” suffix indicating a quick disconnect fitting for patient cuffs. Prior versions had a luer fitting. This manual includes information relating to both fittings.*

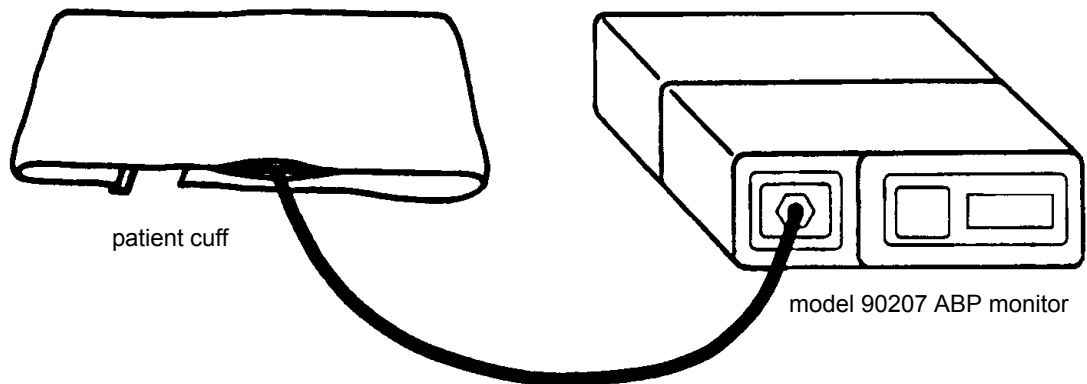


Figure 1-1: 90207 ABP monitor

The 90207 ABP monitor includes the following features:

- four-digit LCD display
- battery powered operation
- serial communications port (infrared)
- front panel START/STOP button
- blood pressure cuff
- carrying pouch with shoulder strap

## Description

This ABP monitor is carried in a pouch that is strapped and/or belted at the patient's side. Blood pressure and heart rate measurements are taken using a pressure cuff attached around the patient's arm. An ABP analysis system programs the monitor and specifies the monitoring period, patient information, time format, measurement interval, monitor tone ON/OFF during selected periods, event code display, and whether or not to display readings. Information is transferred either over a modem link or over a cable connection between the monitor and the ABP analysis system.

### Front Panel

The front panel of the monitor includes the LCD display, the cuff hose connector, and the START/STOP button. The figure below illustrates the ABP front panel.

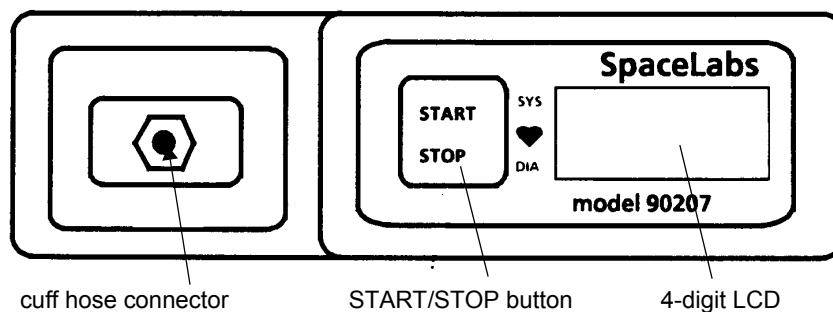


Figure 1-2: Front panel

### Rear and Top View

The rear panel of the monitor contains the communications port and the power ON/OFF switch.

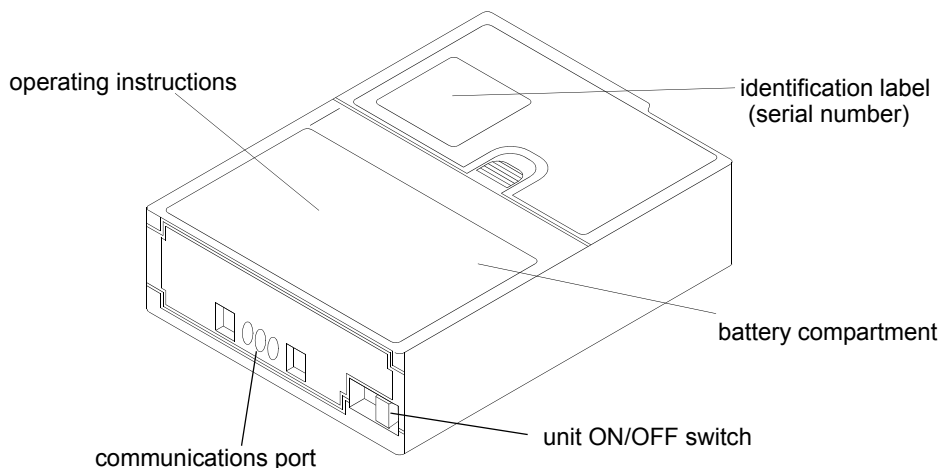


Figure 1-3: Rear panel and top panel

The top panel provides the unit's model number, serial numbers, and abbreviated operation instructions.

## ABP System Options

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ABP analysis systems are used to program the ABP monitor, retrieve collected patient data, and generate blood pressure reports from the acquired data. Current analysis systems available are:

- Model 90121 Ambulatory Blood Pressure Report Management System
- Model 90219-02 Personal Computer Direct Interface software for IBM PC XT or AT compatible (5.25-inch diskettes)
- Model 90219-03 Base Station Interface software for connection by modem
- Model 90219-05 PC Direct Interface software for FT Holter Analysis Workstations
- Model 90229 Local Report Generator
- Model 90239A Report Generator with thermal printer
- Model 92506 Ambulatory Blood Pressure Management System

Spacelabs Medical software is available for both direct and remote ABP monitoring and reporting. Refer to Spacelabs Medical Model 90219 *ABP PC Interface/Base Station Interface* Operations Manual (P/N 070-0238-xx) for descriptions of the available options and operation configurations.



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### Caution

**Observe precautions for handling electrostatic-sensitive devices!**

**Note:**

- *Never touch electrostatic-sensitive electronic components without following proper anti-static procedures, including the use of an ESD wrist band and mat. An electrostatic discharge from your fingers can permanently damage electronic components.*
- *All static-sensitive electronic components are packaged in static-shielding bags. Retain the bag for repackaging the component should you need to store it or return it to Spacelabs Medical for any reason.*

## Hardware Requirements

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For analysis systems using an IBM PC XT or AT compatible computer, the following hardware is required to run the ABP analysis systems (except for the 90229 and 90239A).

**An IBM PC XT or AT compatible computer with the following features:**

One floppy disk and one hard disk drive with a minimum of 512 KB available random access memory (RAM).

IBM color graphics card with a color monitor, or a composite (black and white) monitor, or a Hercules monochrome graphics card with a monochrome monitor.

At least one available serial port for the Model 90219-02, 03.

## Setup Instructions for the 90121

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- 1 Start Microsoft Windows.
- 2 Insert the ABP Report Management System Setup disk in drive A.
- 3 From the **File** menu, choose **Run**.
- 4 Type **A:SETUP** and press **Enter**.
- 5 When prompted, choose the desired operating language.
- 6 When prompted, enter the desired directory location of the ABP Report Management System.
- 7 When prompted, remove the Setup disk and insert Program Disk #1 into drive A.
- 8 When prompted, remove the Program Disk #1 and insert Program Disk #2 into drive A.
- 9 When prompted, restart the Windows operating system and remove the Program Disk #2.

## Setup Instructions for the 90219 and 92506

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**Note:**

*Refer to the 90219 Ambulatory Blood Pressure PC Base Station Interface (P/N 070-0238-xx) or the 92506 Ambulatory Blood Pressure Report Management System Client Application (P/N 070-0932-00) for setup and operating instructions.*

## Installation

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Data collected by the Model 90207 ABP monitor may either be transferred to a standalone report generator or to an ABP analysis system running on an IBM PC XT/AT/PS2 or equivalent computer for data analysis, report printing, and archiving.

Five modes of data interface operation are possible:

- Standalone Report Generator (a 90229 or 90239A Report Generator)
- PC Interface (direct connect using a 90219-02 or 90219-05 PCI for FT1000/FT2000/FT3000)
- ABP Base Station (modem connection using a 90219-03).
- ABP Report Management System 92506
- ABP Report Management System 90121

Refer to the appropriate operations manuals for setup configurations and initialization instructions.

Prior to patient monitoring, the ABP analysis system must initialize the ABP monitor.

### Caution

**The monitor should be disconnected from the patient during initialization. Be sure that power to all hardware is OFF when connecting the ABP monitor for initialization. If power switches are left ON during the connections, improper operation can result.**

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## Power Supplies

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All power required for operation of the Model 90207 ABP Monitor is derived from the four user-installed AA cells. A 3-volt lithium battery provides memory (CMOS) backup.

### Power Converter

A MAXIM "MAX631" step-up converter develops a +5 unregulated voltage whenever battery potential drops below approximately +5.7 volts. This converter also provides an additional 45 kHz square wave output to develop the +10 and -5.0 volt unregulated supplies.

### +5 Unregulated Supply

The +5 volt unregulated supply is powered directly from +VPS (main battery voltage) through a diode when the voltage is above +5.7 volts, and is powered by the step-up convertor when the voltage drops below approximately +5.7 volts. The step-up convertor prevents the +5 unregulated supply from dropping below +5.0 volts.

If the +5 unregulated power supply drops below 5.0 volts, the RAM protect circuit asserts a reset signal to the processor that protects unit memory from a data loss during a power collapse. A start-up processor reset signal with a 40 msec time constant is provided when power is initially applied. The +5 unregulated supply needs approximately 30 msec to reach its full potential. This requires that the processor be held in a reset condition for approximately 70 msec after unit power is first applied.

### Battery OK Status

The 90207 main battery voltage is monitored by reading the BAT VOLTS with an A/D convertor. A low lithium battery is detected by reading a sample of the lithium battery BB VOLTS with an A/D convertor.

### Power Enable

The power converter is activated when main battery voltage (+VPS) is first applied to the converter's step-up inductor. Three control lines determine if the +VPS supply is turned ON:

- PWR\_ENABLE
- C\_CON
- SHUTDOWN

PWR\_ENABLE activates the various power supplies during a measurement or clock update.

The C\_CON line (cable connected) keeps the power supplies active whenever the communications cable is connected to the unit.

SHUTDOWN overrides both the PWR\_ENABLE and C\_CON lines to cause a power shutdown in the event of a detected fault condition.

### A/D Voltage References

The A/D converter uses two voltage references:

- +ADR (+3.672 volts adjustable)
- +ADR LOW (+1.022 volts)

Both are developed from a precision source (an LM358-1.2) that establishes a voltage reference (+ADR), which is adjusted to +3.672 volts.

### +4.7 Volts

The +4.7 volt regulator circuit compares a divided-down sample of the +4.7 volt supply output against the +ADR reference and adjusts the drive for the two pass transistors (FETs) to compensate for differences between the reference and the output voltages.

Two FETs are used as pass transistors to reduce the voltage drop across them. The +4.7 volt supply provides most of the secondary power and sources approximately 25 mA.

### +8.6 VREF Volts

The +8.6 VREF is developed from the +10 volt unregulated supply. The +8.6 VREF regulator is similar to the +4.7 regulator, except that only one FET is needed, and there are two resistors in the output drive of the circuit's operational amplifier. These resistors ensure that the FET can be turned ON or OFF at the minimum specified output voltage extremes of the OP Amp.

The +8.6 VREF sources approximately 1.6 mA to the pressure transducer and smaller amounts of current to other circuits to produce a total current drain of about 2 mA.

## Other Power Sources

In addition to the regulated power supplies, there are five other power sources in the 90207:

+VSW, +VPS, +VSB, +VAA, and +VBB

+VSW is the voltage coming directly from the unit's main batteries through the power ON/OFF switch. This supply becomes active as soon as the power switch is ON.

+VPS is the power converter supply. When enabled, it is at about the same potential as +VSW, and it is enabled to awaken the microprocessor.

+VSB is activated when +VSW is up and is a diode drop less than +VSW or +4.7 volts, depending on which supply happens to be at the higher voltage.

+VAA supplies the main battery voltage to the 90207 clock and RAM chips when the power switch is OFF and main batteries are present. This design prevents any unnecessary power drain from the unit's lithium battery.

+VBB is the backup battery supply. Its potential is always a diode drop down from the voltage at +VSB or the backup battery potential, whichever happens to be at the higher voltage.

There are two conditions when the +VBB supply will operate from the backup battery:

- the main batteries have been removed
- the main batteries are discharged below 3.0 volts



## Wake Up and Power Up Logic

The 90207 power up sequence can be initiated by any of the following actions:

- Power START/STOP switch turned ON
- START/STOP switch depressed
- REAL TIME CLOCK generates minute change pulse
- IR serial RS-232 cable connected to communications port

The first three of the above actions trigger a wake-up pulse from a one-shot generator to assert the PWR\_ENABLE line and to enable the converter supply. When asserted, the PWR\_ENABLE line applies power to the microprocessor and generates a restart condition, causing the 90207 circuits to awaken. The microprocessor then sets the HOLD line high to keep the converter supply up, even after the wake-up one-shot pulse has timed out (the wake-up one-shot pulse has a duration of approximately 120 msec).

After a wake-up, the microprocessor determines which event initiated the wake-up:

- It checks the C\_CON (cable connected) line to determine if the IR RS-232 serial cable activated the supplies.
- It checks the START/STOP line to see if this button is being pressed.
- It checks the PWR\_SW line to see if the unit was just powered ON.

If none of these three conditions was responsible for waking up the unit, the minute timer is assumed to have generated the wake-up pulse.

### START/STOP Button

Pressing the START/STOP button triggers the wake-up one-shot generator and also generates an interrupt to the microprocessor that is processed after the converter supplies are activated. The microprocessor has a restart time of about 70 msec. After the restart time, the microprocessor asserts the HOLD line and processes the interrupt (if the IR RS-232 cable is not connected), which initiates the restart.

### Power Switch

When the main power switch contacts are closed, power (+VSB) is applied to a power switch flip-flop circuit. This flip-flop is then cleared and the PWR\_SW line to the processor goes high (since the processor is not yet powered ON, a resistor is used to protect the microprocessor input).

At the same time, the wake-up one-shot generator is triggered. This in turn activates the converter supplies and awakens the microprocessor. The microprocessor now checks for conditions START/STOP and C\_CON. The PWR\_SW line is read to determine if the power-up condition was initiated by the power switch being ON. If ON, the HOLD line is asserted to clear the PWR\_SW line.

## Minute Pulse

The clock produces a pulse with a duration of 30 seconds every minute. The leading edge of this pulse causes the minute timer flip-flop to change states. A narrow pulse (about 500 nsec) is generated that also resets the flip-flop. This pulse triggers the wake-up one-shot, which in turn powers up the converter and activates the microprocessor.

After waking up, the microprocessor first checks to see if any of the three possible wake-up conditions has awakened it (C\_CON, START/STOP LINE, or PWR\_SW). If none of these three have awakened the microprocessor, the microprocessor then asserts the HOLD line and determines if it is time for a pressure reading. If it is time for pressure reading, the reading is initiated; if it is not time for a pressure reading, the display time is updated, the HOLD line is removed, and the microprocessor returns to its sleep state.

## Cable Connection

If a cable is connected to the 90207 RS-232 communications connector and the power switch is in the ON position, the power converter will be activated, bringing up the microprocessor. When receiving a C\_CON wake-up, the microprocessor gives it priority over the other three wake-up conditions. A C\_CON wake-up also prevents the power converter from being deactivated as a result of a shutdown fault, which might be generated by the watch dog timer or overpressure detector.

After wake-up, the microprocessor goes into a listening mode and waits for instructions from the attached computer. These instructions adhere to the ABP communications protocol.

## Second Pulse

The SECONDS line from the unit's real-time clock is monitored by the watch dog timer to determine how long a pressure reading takes. When the unit wakes up, a reset signal is sent to the watch dog timer, setting it to zero time. When the watch dog counts 256 second pulses, it generates a pulse to activate the fault shutdown flip-flop circuit. The SECONDS line also goes to the display circuit where it is used to blink the display colon and change polarity to the LCD display.

## Watch Dog Timer

The watch dog timer ensures that the cuff cannot remain inflated if the 90207 software crashes. This timer begins counting second pulses from the real-time clock at converter power up. When it counts up to 256-second pulses, the diode-connected outputs of the counter go high, causing a transistor to pull low on the trigger input of the fault shutdown one-shot generator. This triggers a 25-second pulse, which asserts the shutdown line.

## Fault Shutdown

The fault shutdown circuitry causes the power converter to shut down. It also disables the pressure pump and opens the pressure release valve until the shutdown circuit times out in approximately 25 seconds. Shutdown can be caused by two conditions:

- There is an overpressure situation that is not detected by software.
- The pressure reading takes longer than 256 seconds. This duration indicates a software crash, because there is also a 180-second software time-out that should have already stopped the reading.

## Overpressure Detector

In addition to software overpressure detecting, there is also a hardware overpressure detector (at approximately 310 mmHg) that detects an overpressure situation that lasts longer than one-half of a second. This small delay prevents motion artifacts from causing false overpressure detection.

## Pressure Amplifier

The pressure amplifier circuitry amplifies voltage produced across the pressure transducer. This voltage is proportional to the pressure in the arm cuff. The pressure transducer requires compensation to make the voltage output linear with pressure. This compensation is accomplished with a reference voltage and a current source. The current source provides an output that increases as the voltage across the bridge decreases. This linearizes the transducer's output voltage.

Voltage across the transducer is amplified differentially and converted into single-ended voltage. This voltage is amplified and sent to the A/D converter (ADC0848), the oscillometric amplifier, and the overpressure detector.

## Offset Adjust

Transducer offset is nulled out using a pressure offset adjustment. Minor variations in the offset are tracked and compensated for through software.

## Gain Adjust

Variations in gain can be compensated for with gain adjustment. The voltage gain to the A/D converter is +14.4 mV/mmHg. This voltage is offset by about 0.2 volts. The 0.2 volts is inserted into the last stage to prevent the signal to the A/D converter from going negative. The 0.2-volt offset is subtracted with software.

## Pressure Amplifier Filters

Some filtering is done in the pressure channel to reduce the effect of the pumping action, which adds pulses to the pressure in the cuff. A 23-Hz low pass filter serves this purpose. The R-C combination at the pressure output prevents the A/D converter loading from affecting the oscillometric waveform.

## Oscillometric Amplifier

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The first two stages of the oscillometric amplifier are a 2-pole low-pass filter and a 2-pole high-pass filter. Together, these filters produce an insertion loss of 30%. The center frequency of the pass band is 2 Hz; the 3-db points are at about 0.9 Hz and 5.5 Hz. During cuff bleeds and cuff inflation, the high-pass filter is restored to charge the coupling capacitor up to the new pressure level voltage. This helps reduce filter settling time.

Filtering has the effect of narrowing the oscillometric pulse width and generating a pulse with an amplitude that is proportional to the rising edge of the oscillometric input waveform and its original amplitude. The oscillometric pulse is similar to a half-sine wave with an extended trailing edge.

### Gain Switching

Gain switching is provided by the oscillometric amplifier to account for varying amplitudes of the oscillometric pulse. Switching is done by using switching gain resistors with analog switches (DG211) selected by the GAIN\_0 and GAIN\_1 lines. Gain can be selected at 2, 4, 8, or 16.

### Offset and Limiting

The offset stage offsets the voltage to the A/D converter to prevent negative voltages from going to the converter. The input offset of the amplifiers can cause as much as 0.6 volts of unwanted offset at the oscillometric output. Offset is subtracted out with software.

The last stage in the oscillometric amplifier limits the output swing from 0 to +4.7 volts to prevent over-driving the A/D converter input.

## Digital Circuitry Display Board

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Information is sent from the microprocessor to the LCD controller by a serial bus (CBUS). The LCD controller activates the necessary segments separately to display information on the 4-segment LCD. The microprocessor determines what segments are to be turned on, sending this information to the controller.

An exclusive OR gate blinks the colons once each second when in the clock mode, and it also changes polarity of the drive.

## Real-Time Clock

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The real-time clock uses a serial data bus to send and receive information. This bidirectional bus is divided into two lines (transmit and receive) that go to the microprocessor. If the main batteries are removed, the clock will be backed up for approximately 2 minutes by the 3-volt lithium cell.

## RAM

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RAM is a 32 KB x 8 bit device for storing both patient collected information and programmed information. RAM data is backed up during main battery removal by the 3-volt lithium cell.

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## Addressing and Control Lines

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Unit addressing and control is accomplished with a combination of microprocessor ports, two latches, and one-half of a multiplexer circuit. The 74HC174 latch controls the motor, valve, alert, gain switching, and hold line. A 74HC373 provides address latching for the RAM.

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## Communications RS-232 Connector

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The 90207 communications connector is a modified RS-232 interface. When the communications cable (IR cable) is connected to the back of the 90207, a reed relay is activated, causing power to be applied to the ABP unit.

The microprocessor checks and determines that the C\_CON line is asserted. It then goes into communication mode. The microprocessor must then determine whether the cable is communicating with a modem, a PC direct interface, or a local report generator. It then responds accordingly.

Communications are accomplished by means of a transmit and a receive line. The data is converted into IR signals.

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## Microprocessor

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The 90207 uses a 80C51 microprocessor with a 7.272-MHz crystal. This chip contains on board RAM and ROM. Four 8-bit ports provide the data lines, the addressing, and the control and serial bus lines.

The on-board ROM provides routines for communications and start up. The majority of the program is loaded into RAM using the IR RS-232 port.

One interrupt is used, and it is initiated by these following conditions:

- The START/STOP line goes low
- The PWR\_SW line and the ADC INT lines go low (lowest-priority interrupt)



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### Caution

**Observe precautions for handling electrostatic-sensitive devices!**

**Note:**

- *Never touch electrostatic-sensitive electronic components without following proper anti-static procedures, including the use of an ESD wrist band and mat. An electrostatic discharge from your fingers can permanently damage electronic components.*
- *All static-sensitive electronic components are packaged in static-shielding bags. Retain the bag for repackaging the component should you need to store it or return it to Spacelabs Medical for any reason.*

Periodic maintenance consists of cleaning the exterior of the unit, replacing or recharging the monitor batteries, and calibrating the unit for accurate operation.

## Cleaning

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Use a soft, damp cloth and mild detergent mixed with water to wipe the exterior of the monitor. Clean the carrying pouch and air hose with isopropyl alcohol.

The cuff wrap may be sterilized only by ethylene oxide (ETO) sterilization methods, using standard hospital procedures. Use standard aeration techniques after sterilization. Small soiled or stained areas may be cleaned by gentle scrubbing with a sponge or cloth soaked in a mild soap and water solution.

The cuff wrap (with the air bladder removed) is machine washable on “delicate” cycle only. Do not wash with bed linens and gowns or in large commercial-type washers.

**To remove the bladder for cleaning, refer to the figures on the next page and follow these steps:**

- 1 Using your fingers only, fold or roll up the bladder inside the cuff. Do not use pencils, pens, or other hard objects, because damage to the bladder could easily occur.
- 2 Remove the bladder through the hose exit opening. After the bladder has been removed, be sure to again mate the hook-and-loop surfaces on the cuff before washing.
- 3 After washing and drying the cuff, reinstall the bladder in the reverse order, as previously described. Make certain that any folds in the bladder are removed before inserting it back inside the cuff.

**Note:**

*The bladder may be installed with the hose exiting the second cuff opening. However, the bladder must be positioned with its long side toward the center of the cuff.*

## Battery Replacement

Two types of replaceable batteries are used in the 90207 ABP Monitor: four AA batteries (Spacelabs Medical part number 146-5011-00) that power the cuff air pump, and one lithium battery (3 volts, Spacelabs Medical P/N 146-0008-00) that preserves the information held in the monitor's memory circuits.

If alkaline batteries are used for the AA batteries, they must be replaced after each patient use. Nickel cadmium batteries require a full recharge after each use. The lithium battery should be replaced with a fresh battery every three years.

### AA Batteries

**Note:**

*If batteries are being replaced during patient testing, their replacement must be completed within 1 minute to guarantee successful resumption of the test.*

**To replace the four monitor AA batteries:**

- 1 Power the monitor OFF using its rear panel ON/OFF switch.
- 2 Remove the battery compartment cover plate by pulling back and up on the provided latch.
- 3 If present, remove the old AA batteries from the monitor and replace each with a fresh alkaline (or fully charged nickel cadmium) battery, being careful to observe the voltage polarity (+ or -) as identified in *Figure 4-1*.

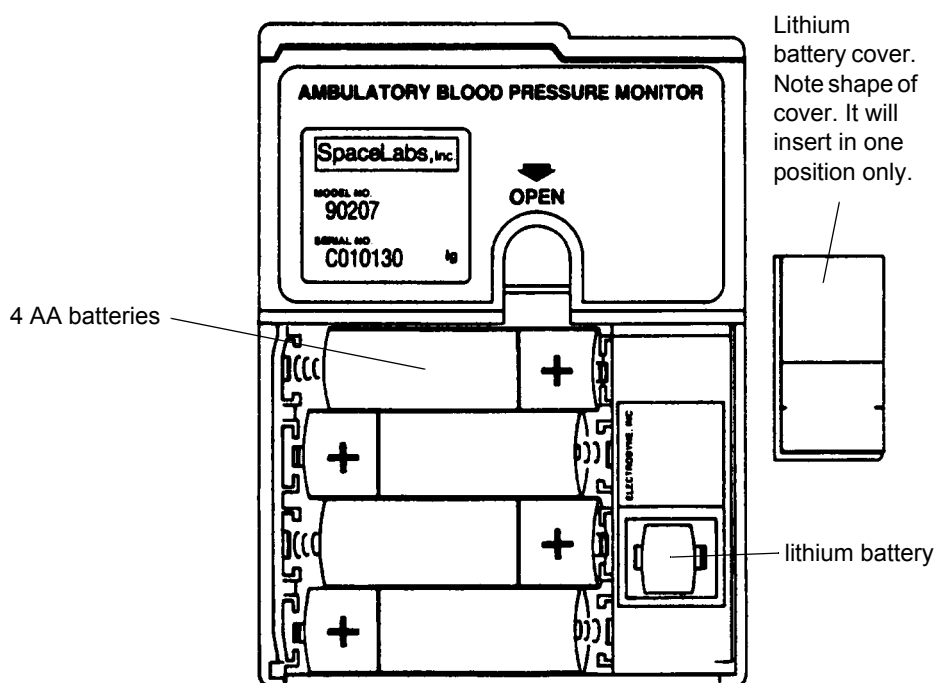


Figure 4-1: Battery compartment

**Note:**

- *The monitor will not operate if either the alkaline or the lithium batteries are incorrectly installed.*
  - *If the monitor is going to be stored for over two weeks, remove the batteries to prevent the possibility of leakage or discharge. Spacelabs Medical is not responsible for product damage incurred as a result of battery leakage. In the event that your unit has been damaged from a leaky battery, contact the battery manufacturer for any recoverable repair or replacement costs.*
- 4 After replacing the batteries, gently replace the battery cover and secure the latch.
  - 5 Turn ON the monitor. Check that the display is ON. If there is no display, power the monitor OFF and refer to *Maintenance* on page 4-1.

## Lithium Battery

The expected life for the 3V lithium battery is 10 years; however, Spacelabs Medical recommends that it be replaced before three years of use.

**To replace the lithium battery:**

- 1 Power OFF the monitor using the rear panel ON/OFF switch.
- 2 Remove the battery compartment cover plate by pulling back and up on the provided latch.
- 3 Remove the protective cover from the lithium battery, taking note of the battery position (polarity of cell and socket indicators).
- 4 Remove the old lithium battery by carefully prying it out (curved forceps are recommended).
- 5 Install the new lithium battery, observing the correct polarity.
- 6 Replace the battery's protective cover (step #3).
- 7 Replace the battery compartment cover plate (step #2).

## Battery Clip Upgrade

Please verify that you have the part before beginning:

Quantity	Part Number	Description
3	131-1218-01	Battery clip, 90207

## Tools Required

- Needle-nose pliers
- Fine-tipped flat screwdriver

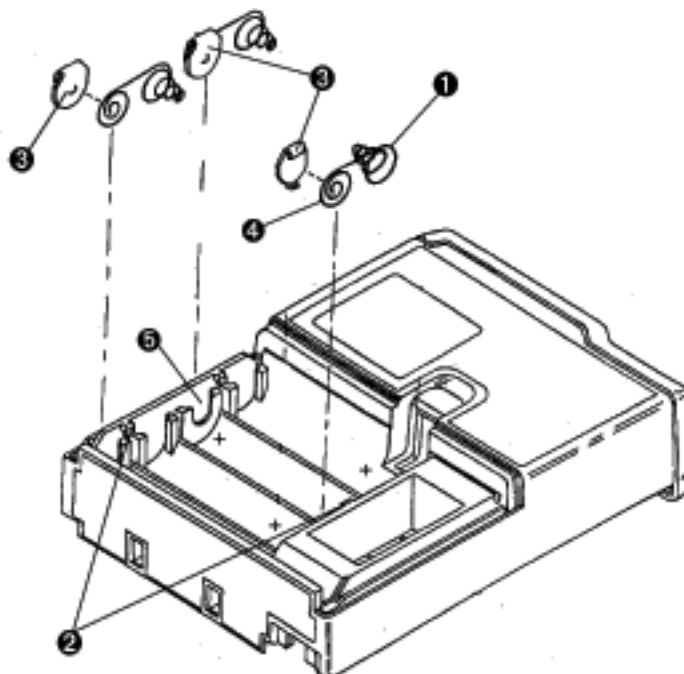
## Installation Instructions

- 1 Remove the battery cover from the 90207. Refer to *Figure 4-2: Battery contact clip installation*.
- 2 Using a fine-tipped flat screwdriver, remove the three twin-spring contacts (1) by gently prying the contacts out from under the molded retaining hooks (2).

**Note:**

*Use extreme care not to break the retaining hooks.*

- 3 Insert each new battery contact clip (3) over the short spring (4) (+ terminals) (refer to *Battery contact clip installation* on page 4-4).



*Figure 4-2: Battery contact clip installation*

- 4 Orienting the metal bump on the contact toward the battery with all coils under the contact tab, slide the contact and spring assembly back down into the case slots. Ensure that the contact is inserted into the case slot (5) facing the battery slot.
- 5 Carefully press down and position the center part of the spring assembly under the plastic retaining hook.
- 6 Ensure that each battery clip is securely in place and makes good contact with an installed battery.

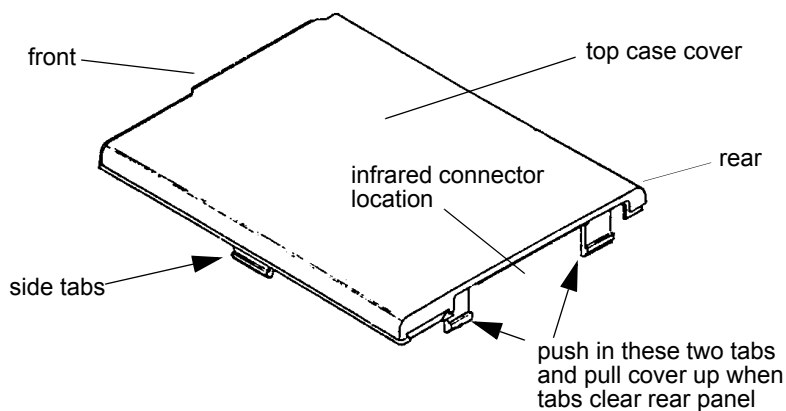
**Note:**

*The last battery in the center of the unit does not require the installation of a battery clip.*

## 90207 Disassembly Procedure

**To remove the top case cover and gain access to the internal components:**

- 1 At the rear of unit, use two small screwdrivers (or similar tools) to press in on the cover's two locking tabs until the tabs both clear contact with the rear panel (the tabs are located on each side of the infrared connector, refer to *Figure 4-3: Top cover removal*).



*Figure 4-3: Top cover removal*

Apply sufficient pressure to lift the cover and pull the two side tabs free. Be sure to pull from the rear of the cover. The front of the cover is tucked under the front panel and it cannot be pulled out until the locking tabs are free from the case.

- 2 When the locking tabs are pulled out of the case, pull the cover away from the front panel to free it from the unit.

## Accuracy Procedure

To check the accuracy of the monitor:

- 1 Disconnect the cuff hose from the monitor. Connect the T-tube splitter to the monitor pneumatic connector and the sphygmomanometer.
- 2 Wrap the pressure cuff around the rigid cylinder, and then fasten the cuff. Connect the cuff hose to the remaining connection on the T-tube splitter. The test setup should appear as shown below.

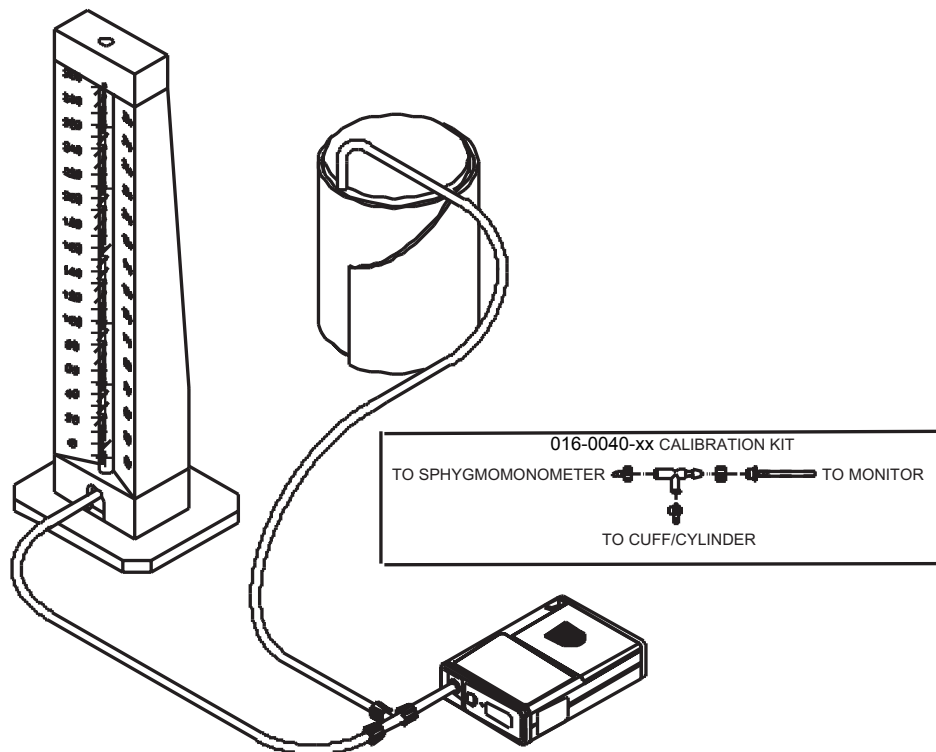
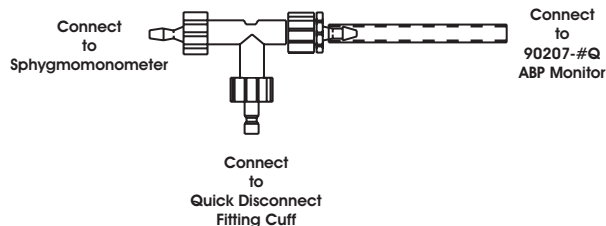
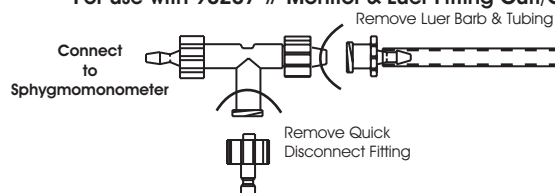


Figure 4-4: T-Tube connection

For use with 90207-#Q Monitor & Quick Disconnect Cuff/Can



For use with 90207-# Monitor & Luer Fitting Cuff/Can



- 3 Press **START/STOP** on the monitor; the monitor should read approximately 165. Compare the readings on the monitor and the manometer as the pressure bleeds down. The monitor reading should be within three millimeters or 2% of the manometer reading, whichever is greater ( $\pm$  the accuracy of the manometer).

**Note:**

*If the monitor pressure values fall outside the allowed tolerance, call your local Customer Service Representative or Spacelabs Medical for servicing.*

- 4 At the end of the procedure, the monitor displays an event code indicating that no dynamic blood pressure measurements were obtained.
- 5 Disconnect the T-tube splitter from the monitor. Disconnect the air hose and sphygmomanometer.

## Calibration Procedures

---

Complete the following procedures to calibrate the Model 90207 ABP Monitor.

### Test Equipment Required

**Note:**

*Any test equipment listed below can be replaced with equivalent models.*

- 1 Tektronix 7603 or TDS420 oscilloscope
- 7A22 or AM502 Differential Amplifiers
- 7B53A Dual Time Base
- DM501A Digital Multimeter
- FG501A Function Generator
- PS503A Dual Power Supply
- BK 1630 DC Power Supply
- Fluke 8052A Digital Multimeter
- IBM PC-AT (or compatible) loaded with 90207 manometer mode software (P/N 063-0165-00) and 90209 to PC cable assembly or 90219 software
- 90209 Data Interface Unit or 90219-02, -03
- IR Direct Connect Cable Assembly (P/N 012-0097-xx)
- Temperature-controlled soldering station
- Analog or digital sphygmomanometer
- Two-hole pressure can (made from empty pint paint can with lid and two 1/8-inch outer diameter brass fittings soldered on)
- Squeeze bulb with tubing and T-fittings
- 1000  $\mu$ F or greater capacitor
- 1  $\mu$ F capacitor

### Tools Required

- Needle nose pliers
- Hemostats
- Diagonal cutters
- Small Phillips screwdriver
- Small flat-tip screwdriver
- Anti-static equipment
- Tweezers
- Small cleaning brush (acid brush)
- Small gauge wire strippers
- Utility knife
- Soldering iron with small tip

## Solvents/Compounds Required

- Isopropyl alcohol
- Rosin core solder

## 90207 Main Board Components

Refer to *Figure 4-5* to identify test points and other components when conducting calibration and verification procedures for PCBAs P/N 670-0303-10 (and earlier versions).

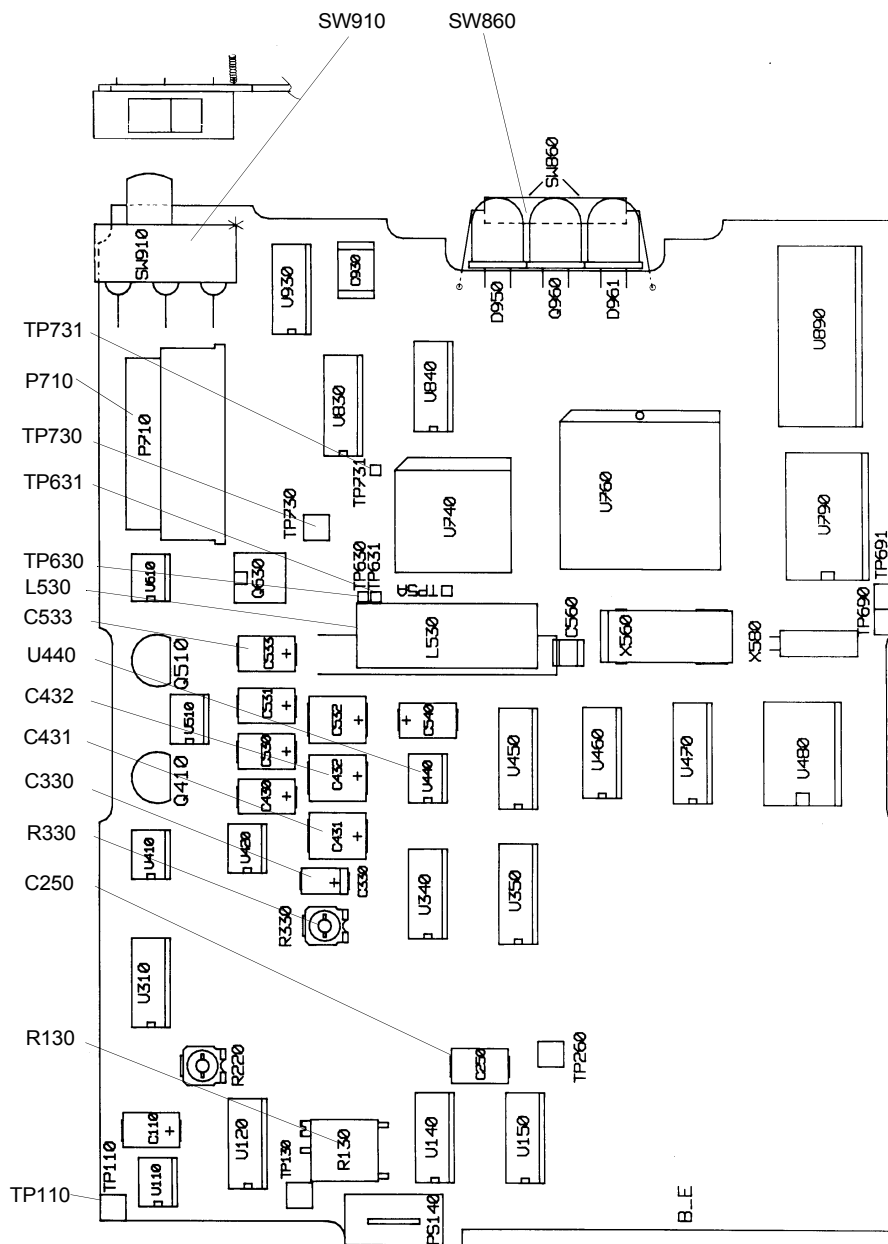


Figure 4-5: Main board components for P/N 670-0303-10 (and earlier versions)

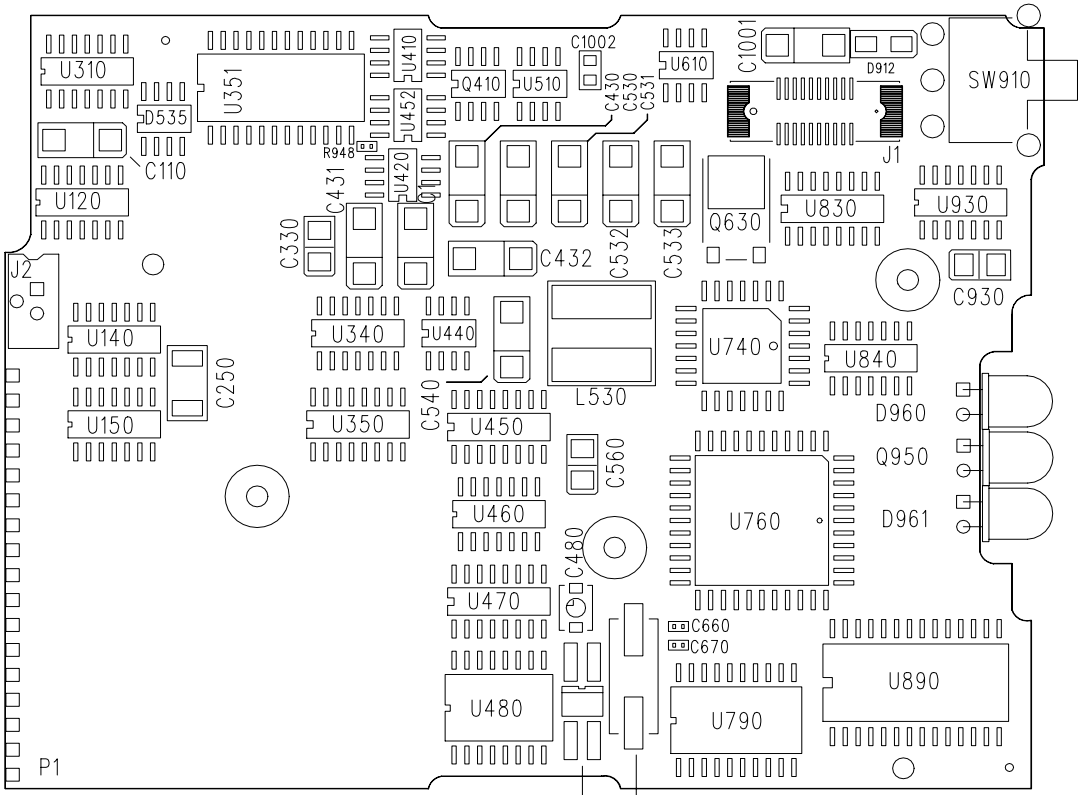


Figure 4-6: Main board components (front view) for P/N 670-0303-11 (and later versions)

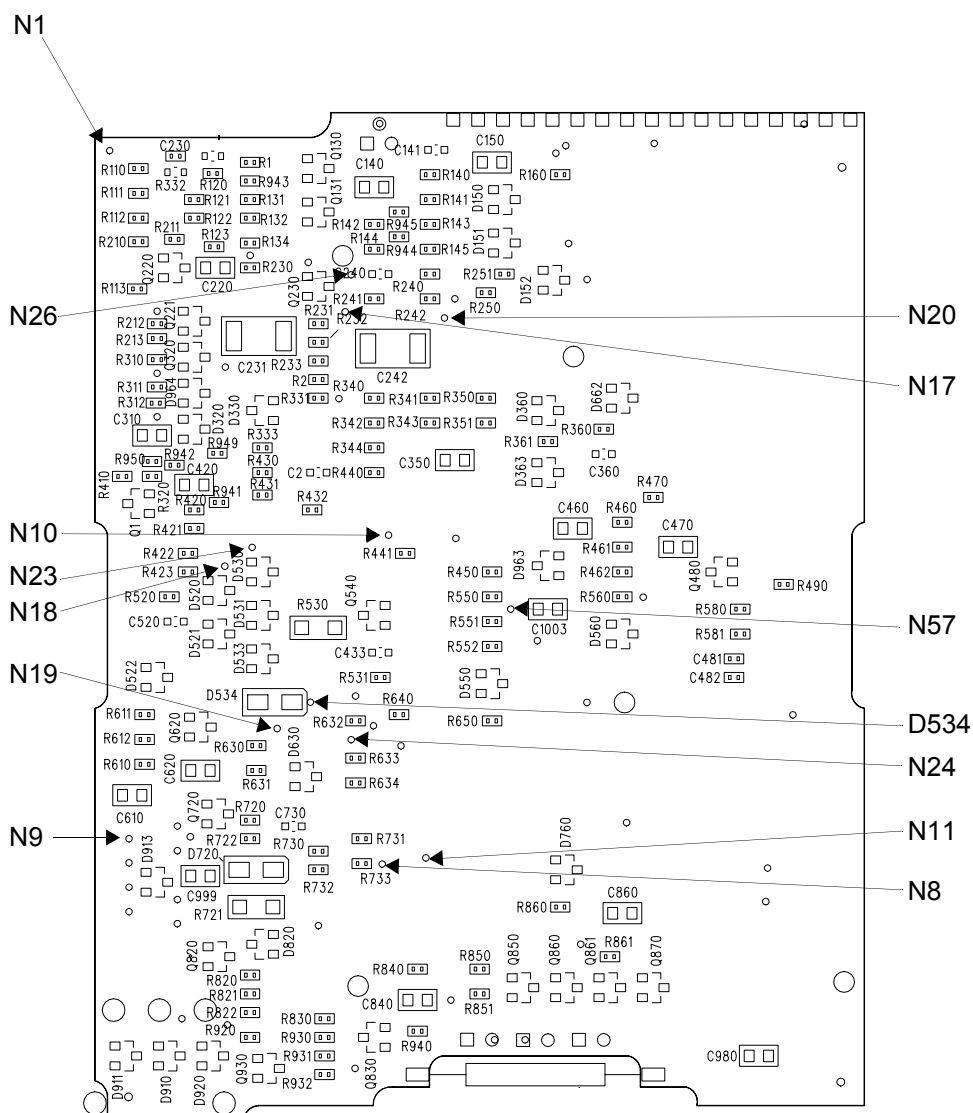


Figure 4-7: Main board components, back view, for P/N 670-0303-11 (and later versions)

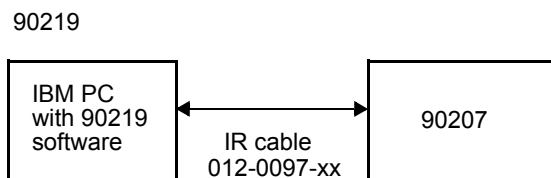
## Computer System Setup

The following equipment is required to set up the test computer required for 90207 calibration:

- IBM PC (or compatible) loaded with manometer mode software (P/N 063-0165-00)
- 90209 Data Interface Unit or 90219 PCDI software
- 90209 to PC Cable Assembly
- IR Direct Connect Cable Assembly

To set up the computer system (refer to *Figure 4-8*):

computer system block diagram



*Figure 4-8: Computer system block diagram*

- 1 Connect power to the 90209 Data Interface Unit.
- 2 Connect the 90209 to PC cable between the 90209 and the IBM PC. Use the proper cable for either a PC AT or XT, depending on the computer being used.
- 3 Connect the IR Direct Connect Cable Assembly to the 90209 at the 90207 connection.

**Note:**

- Refer to the 90219 operations manual if not using a 90209 for these procedures.
- The test equipment settings specified in these procedures are for reference only.
- The power supply must have a 1000  $\mu$ f or greater capacitor connected between the plus (+) and minus (-) terminals and must be within three inches of where the power is applied to the flex board.
- The calibration adjustment on the dual time base must remain in the CAL position (fully clockwise) when making timing measurements. The SOURCE selection should remain in the INT position.
- The ground wire of the test lead must be connected to the power ground of the circuit board under test whenever measurements are made using the differential amplifier.

## Power Supply Check

To check the Model 90207 power supply:

- 1 Set your oscilloscope as shown below.

Time/Div	5 ms
Volts/Div	10 mV
Mode	AUTO
+ Input	AC
Coupling	AC
HF -3 dB Point	10kHz
LF -3 dB point	DC

- 2 Set the power supply output to 5.7 VDC  $\pm$ 0.1 VDC.
- 3 Connect the power supply to the 90207 monitor at the positive (+) and negative (-) AA battery terminals:

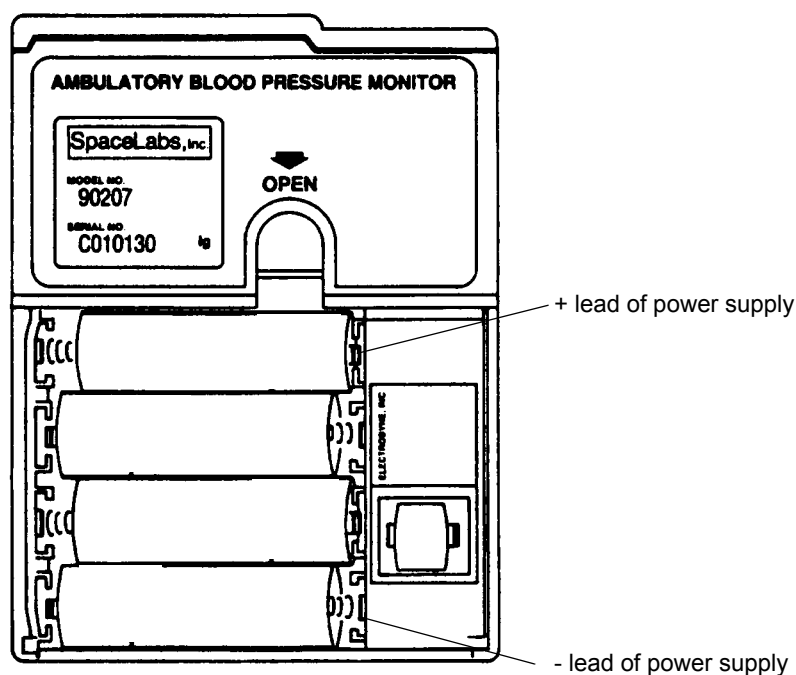


Figure 4-9: Power supply

- 4 Ensure that the ON/OFF switch (SW910) is in the OFF position. Verify a voltage reading of 0.0 V at +VSW (P710, pin 2). For P/N 670-0303-11 assemblies (and later versions), verify the voltage at N9. Use N17 (AGND) as ground reference. Refer to Figure 4-7 on page 4-11 to verify pad location.

- 5 Slide the ON/OFF switch to the ON position and verify the following:
  - a The LCD shows the current ROM version number followed by the time.
  - b A sleeping current draw of less than 300  $\mu$ ADC (monitor is in sleep state when LCD shows time).
  - c A voltage reading of +5.7 VDC at +VSW.
- 6 Connect a jumper lead across the reed switch (SW860). The LCD will show "9999".
- 7 Verify a current flow of less than 30 mA.
- 8 Verify a voltage reading of greater than +5.65 VDC at + VPS (L530) for P/N 670-0303-10 and earlier versions. For P/N 670-0303-11 and later versions, verify the voltage reading at the cathode side of D534. Refer to figure *Figure 4-7* on page 4-11.
- 9 For main board assemblies P/N 670-0303-10 (and earlier versions) set the ADR reference voltage, measured at +C330, to 3.672 V  $\pm$  0.001 V by adjusting point R330. To locate this point, refer to *Figure 4-5* on page 4-9.  
  
Main board assemblies of P/N 670-0303-11 (and later versions) require a board test fixture to calibrate ADR. If ADR is out of specification, recalibrate on an ABP board test fixture. ADR can be measured at N10. To locate this point, refer to *Figure 4-7* on page 4-11. Use N17 (AGND) as ground reference.
- 10 Refer to the table below and verify each voltage specification.

**Note:**

*In the following checks and adjustments, TP730 must be used as a ground test point for board assemblies P/N 670-0303-10 (and earlier versions). For board assemblies P/N 670-0303-11 (and later versions), use N17 (AGND) as ground reference. Refer to Figure 4-7 on page 4-11 to verify pin location.*

## Power Supply Voltage Specifications

*Table 1: Specifications for Board Assemblies 670-0303-10 and earlier versions*

Supply	Location	Voltage (VDC)	Range (VDC)	Ripple (mVPP)
ADR Low	TP731	1.022	1.009 to 1.035	<10
+4.7 V	+C431	4.7	4.69 to 4.71	<50
+5 V UR	+C432	5.45	5.1 to 5.65	<100
-5 V UR	-C430	-4.45	-4.0 to -4.7	<50
+10 V UR	+C533	9.75	9.0 to 10.5	<50
+8.6 V Ref	+C250	8.6	8.575 to 8.625	<20

Table 2: Specifications for Board Assemblies P/N 670-0303-11 and later versions

Supply	Location	Voltage (VDC)	Range (VDC)	Ripple (mVPP)
ADR Low	N8	1.022	1.009 to 1.035	<10
+4.7 V	N11	4.7	4.69 to 4.71	<50
+5 V UR	N18	5.45	5.1 to 5.65	<100
-5 V UR	N23	-4.45	-4.0 to -4.7	<50
+10 V UR	N19	9.75	9.0 to 10.5	<50
+8.6 V Ref	N20	8.6	8.575 to 8.625	<20

## Amplifier Calibration

### Pressure Amplifier

- 1 Monitor TP731, ADR\_LOW, with a DVM. For P/N 670-0303-11 (and later versions), monitor N8. Refer to *Figure 4-7* on page 4-11.
- 2 Check for  $1.0224 \text{ V} \pm 0.0144 \text{ V}$ .
- 3 Monitor TP630, PRESS, with a DVM. Monitor N24, PRES\_OUT, for P/N 670-0303-11 assemblies (and later versions). Refer to *Figure 4-7* on page 4-11.
- 4 For main board assemblies of P/N 670-0303-10 (and earlier versions), adjust R130 to  $0.1872 \text{ V} \pm 0.005 \text{ V}$ .  
For main board assemblies of P/N 670-0303-11 (and later versions), the ABP system test fixture is required to adjust pressure offset.
- 5 Connect the pressure bulb manometer and standard two-hole can to the input (refer to *Figure 4-10* on page 4-16). Clamp the hose to the bleed valve using the hemostats.

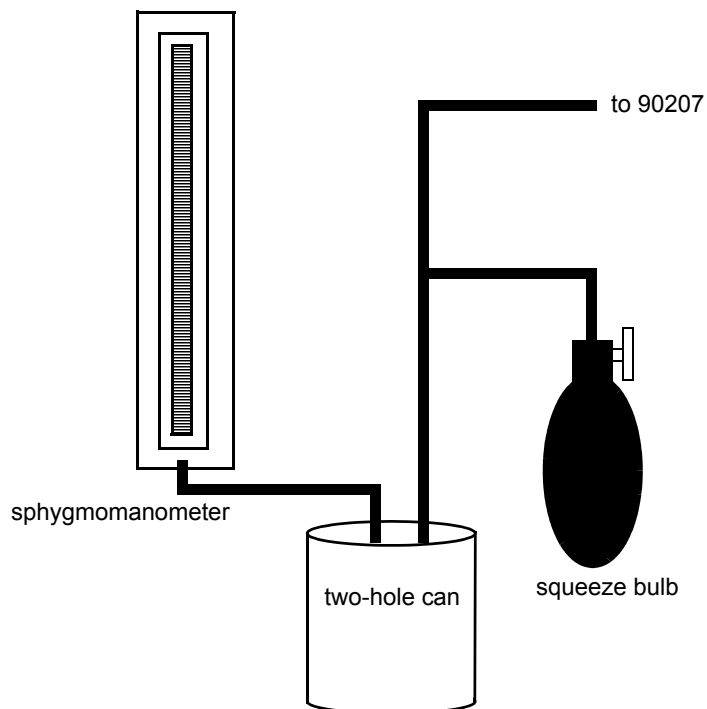


Figure 4-10: Sphygmomanometer test configuration

- 6 Connect the 90207 monitor to the PC and run the manometer mode software.
- 7 Manually pump the bulb to apply 200 mmHg pressure to the system.
- 8 Verify a voltage reading of between 3.060 VDC and 3.070 VDC at TP630 (sphygmomanometer and display must read 200 mmHg). Monitor N24, PRES\_OUT, for P/N 670-0303-11 assemblies (and later versions). Refer to *Figure 4-7* on page 4-11.
- 9 Check the following voltages for each given pressure reading (if any adjustment is made, all pressure and voltages must be verified again).

Pressure	Voltage
300 mmHg	4.507, $\pm 0.02$
250 mmHg	3.787, $\pm 0.01$
200 mmHg	3.067, $\pm 0.01$
150 mmHg	2.347, $\pm 0.01$
100 mmHg	1.627, $\pm 0.02$
50 mmHg	0.907, $\pm 0.02$
0 mmHg	0.187, $\pm 0.01$

**Overpressure Detector**

- 1 Monitor U440 pin 7 with an oscilloscope for main board assemblies P/N 670-0303-10 (and earlier versions). Monitor N57 for main board assemblies P/N 670-0303-11 (and later versions). Refer to *Figure 4-7* on page 4-11.
- 2 Slowly increase the pressure while observing the manometer.
- 3 For P/N 670-0303-10 assemblies (and earlier versions), verify that U440 pin 7 goes low between 305 mmHg and 320 mmHg. For P/N 670-0303-11 (and later versions), verify this measurement at N57.
- 4 Relieve the pressure in the system.

**Noise**

- 1 Configure the oscilloscope as follows:

Model 7A22

Window: DC - 3 kHz

Volts/Div: 50 mV/Div

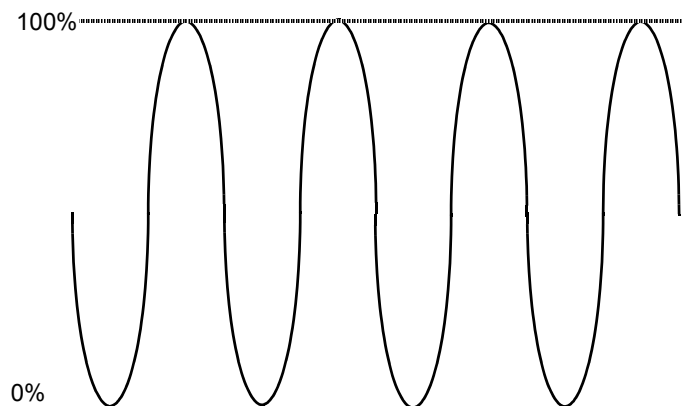
Input: AC +

- 2 Check TP630, PRESS, for <10 mV of noise. Monitor N24, PRES\_OUT, for P/N 670-0303-11 assemblies (and later versions). Refer to *Figure 4-7* on page 4-11.

**Oscillometric Bandpass**

- 1 Connect a 1 $\mu$ F capacitor between the scope probe and TP631 (OSC\_OUT) for P/N 670-0303-10 assemblies (and earlier versions). For 670-0303-11 assemblies (and later versions), connect the probe to N26 (OSC\_OUT). Refer to *Figure 4-7* on page 4-11.
- 2 Set the oscilloscope (7A22) to AC, 20 mV/division.
- 3 For P/N 670-0303-10 assemblies (and earlier versions):  
Set the function generator for sine wave, a frequency of 2.5 Hz, free run mode, -60 db (minimum amplitude), and connect it to TP110.  
  
For 670-0303-11 assemblies (and later versions):  
Repeat the previous steps, but disregard the connection to TP110. Instead, connect to point N1. Refer to *Figure 4-7* on page 4-11 to verify the location of this point.
- 4 Adjust the amplitude of the function generator until the OSC\_OUT pressure output signal is 100 millivolts, peak-to-peak.

### 2.5-Hz Signal on Percentage Scale



*Figure 4-11: Signal on percentage scale*

- 5 Decrease the frequency until the amplitude is 70%.
- 6 Verify that the frequency is 0.9 to 1.1 Hz.
- 7 Increase the frequency until the amplitude is at 70%.
- 8 Verify that the frequency is from 5 to 7 Hz.
- 9 Remove the capacitor and hemostats.

### Backup Battery Check

#### To test the lithium battery current:

- 1 With a primary power supply connected across the main battery terminals, set a secondary power supply for a  $2.6 \pm 0.1$  VDC output. Connect a current meter in series with the power supply.
- 2 Remove the lithium battery from its holder.
- 3 With the 90207 power switched OFF, connect the power source to the 90207 at the lithium battery holder terminals (pay attention to terminal polarity).
- 4 Turn the unit ON and start a reading by pressing the START/STOP button, and then verify that an "Lbb" indication does **not** occur.
- 5 Decrease the lithium battery input voltage to  $2.25 \pm 0.05$  VDC.
- 6 Start a reading and verify that an "Lbb" indication **does** occur.
- 7 Reinstall the lithium battery removed in step 2 above.
- 8 Initialize the ABP monitor using one of the ABP systems. Set it to view pressure steps.

### Functional Test

#### To test the operation of the Model 90207:

- 1 Set the primary power supply for a 5.7 VDC output.
- 2 Connect a current meter in series with the supply.

- 3 Remove the four AA batteries from the main battery compartment of the 90207.
- 4 Connect the 5.7 VDC power source to the 90207 at the main battery terminals.
- 5 Turn ON the 90207. The display shows the current ROM version and then the current time; the colon will be flashing.
- 6 Connect the sphygmomanometer test configuration (page 4-11) to the 90207.
- 7 Press the START/STOP button and verify the occurrence of two audible tones.
- 8 Verify that the display begins the countdown sequence; "5555", "4444", "3333", "2222", "1111".
- 9 Verify that the pump starts, the current draw is less than 350 mA, and that the pump reaches its target pressure of 175 mmHg, +/-8 mmHg.
- 10 Verify that the pressure bleeds down in increments of between 7 and 9 mmHg.
- 11 Verify a current drain of less than 55 mA during bleed down. Current spikes of approximately 70 mA are acceptable.
- 12 Verify a rapid succession of tones and a display reading of "EC 08".
- 13 Verify that the display changes from showing the event code to showing the current time.
- 14 Verify that the monitor goes to a sleep mode with a current drain of less than 250  $\mu$ A. Lower the main battery input voltage to 4.8  $\pm$ 0.03 VDC.
- 15 Attempt a reading by depressing the START/STOP button.
- 16 Verify that the display shows "LLL", indicating a low main battery.
- 17 Increase the main battery input voltage to 5.0  $\pm$ 0.03 VDC and attempt a reading.
- 18 Verify that the 90207 performs a normal reading.
- 19 Start another reading. Decrease the main battery input voltage to 4.1 VDC when the 90207 begins to pump.
- 20 Verify that an "LLL" indication does NOT occur.
- 21 Decrease the main battery input voltage to 3.9 VDC while the 90207 is still pumping.
- 22 Verify that an "LLL" indication occurs immediately.
- 23 Increase the main battery input voltage to 5.7 VDC.
- 24 Disconnect the primary power source and reinstall the four AA batteries (observe correct polarity).
- 25 Assemble the 90207 module into the main body case. Make sure that the display board fits completely into the window of the case.
- 26 Fit the case cover over the 90207 module and snap it into place.
- 27 Fit the tabs on the case battery cover into the hinges on the main body case; snap the cover in place.
- 28 Reinitialize the 90207 monitor using the ABP program.

## Operation Verification

The following procedures verify that the 90207 ABP monitor's blood pressure readings are consistent with design standards.

**Note:**

*These procedures refer to use of the DynaTech Nevada CuffLink Blood Pressure Simulator. If you are using a different simulator, refer to its operator's manual to determine equivalent tests. Refer to the end of this Maintenance chapter for instructions on using the CuffLink simulator in automatic or manual modes.*

## Equipment Required

- DynaTech Nevada CuffLink Noninvasive Blood Pressure Analyzer and associated tubing, manuals, luer fittings (software version 2.0 or higher is required)
- 1/8 inch I. D. tubing (P/N 162-0019-00 or equivalent)
- Adult cuff
- Luer connector (P/N 103-0008-00)

## Blood Pressure Simulator Preparation

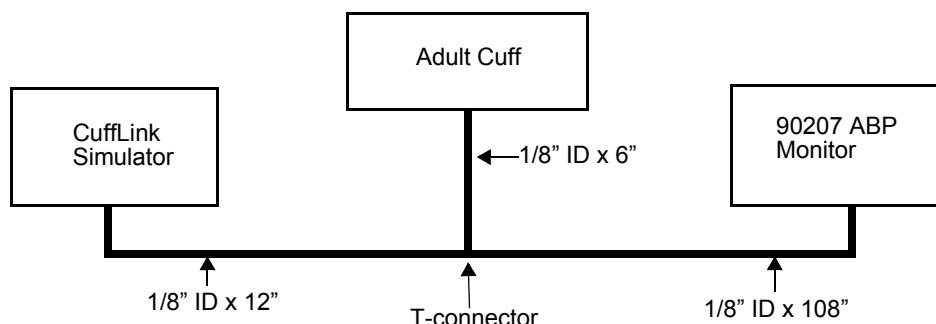
- 1 Verify that the calibration sticker on the simulator is current. If it is not, the simulator will need to be calibrated by the manufacturer or the authorized service facility.
- 2 Turn ON the CuffLink simulator and allow it to warm up for a minimum of 15 minutes.
- 3 Check the zero pressure by selecting ADAMS Adult from SelectBp in the **Main** menu.
- 4 Press ENT.
- 5 Press F5 to zero the pressure.
- 6 Press **Esc** to return to the **Main** menu.
- 7 Perform a leak rate check on the blood pressure simulator and associated tubing as follows:
  - a While in the **Main** menu, move the cursor to Press and select Leak Test by pressing ENT.
  - b Connect a squeeze bulb to the hose which will connect directly to the unit under test.
  - c Pump up the system pressure to approximately 170 mmHg.
  - d Wait 10 seconds for the pressure to stabilize.
  - e Press the START (F1) key on the CuffLink simulator and wait one minute while the leak rate is measured.
  - f At the end of the minute, the leak rate will be displayed on the CuffLink display.
  - g If the leak rate is greater than 10 mmHg per minute, retighten all external hose connections and repeat the test. If the system continues to fail, isolate each length of tubing to locate the source of the leak. Repair the leak.
  - h Press the **Esc** key to return to the **Main** menu.

**90207 Preparation**

- 1 Set up the ABP monitor by connecting it to the CuffLink.
- 2 Refer to the table below for a list of systolic/diastolic/heart rate settings to perform on the unit under test.

Pressure	Setting	Range
Systolic	60	57 to 64
Diastolic	30	26 to 33
Heart Rate	40	
Systolic	100	95 to 106
Diastolic	65	60 to 70
Heart Rate	60	
Systolic	120	113 to 125
Diastolic	80	74 to 88
Heart Rate	80	
Systolic	150	142 to 158
Diastolic	100	92 to 108
Heart Rate	120	
Systolic	200	190 to 210
Diastolic	150	142 to 158
Heart Rate	120	
Systolic	255	243 to 267
Diastolic	195	185 to 205
Heart Rate	120	

- 3 Connect the unit under test to the simulator, as illustrated in *Figure 4-12*.



*Figure 4-12: Test connection*

- 4 Move the CuffLink cursor to SelectBp and press the ENT key to select ADAMS Adult.
- 5 Press the F2 key (AdjEnv) and verify that the gain is at 100%. If it is not, adjust it using the arrow keys. At the same time, verify that OFFSET and/or SHIFT are at 0.
- 6 Press the ENT key.
- 7 Press the Esc key to return to the **Main** menu.
- 8 Move the cursor to AUTO using the arrow keys and select Execute using the ENT key.
- 9 Press the F1 key to select ADULT readings.
- 10 Zero the pressure by pressing the F5 key.
- 11 Press the Esc key until the first pressure simulation reading is displayed on the CuffLink.
- 12 Press the START/STOP button on the ABP monitor to start the reading.

**Note:**

*The CuffLink simulator may automatically change to the next blood pressure setting when the current reading is complete. If it is required to repeat a reading, press the Esc key repeatedly until the ADULT INFANT menu is shown at the bottom of the screen. Press the F1 key to select ADULT readings and then use the Esc key to increment to the reading desired.*

- 13 Repeatedly press the START/STOP button on the 90207 to sequence through the list of blood pressures simulated by the CuffLink.
- 14 At the end of the readings, verify that the systolic and diastolic readings are within given ranges provided in step #2.

**Note:**

*If the readings are out of range, retest the ABP monitor at the same setting. If it still fails, check all hose connections, perform the leak test again, and check the gain settings on the simulator. If all this fails, refer to Troubleshooting on page 5-1.*

## CuffLink Manual Operation

The following steps outline the manual selection of simulated blood pressures and heart rates. These may be used to repeat a reading which was out of range or produced no reading.

- 1 When the CuffLink is warmed up, move the cursor to the SelectBp option of the **Main** menu and ADAMS Adult. Press the ENT key to make a selection.
- 2 Press the F2 key and verify that the gain is set to 100%. At the same time, verify that the SHIFT and/or OFFSET are at 0. Press the ENT key.
- 3 Press the F1 key to move to the **Heart Rate** menu. Use the arrow keys to move the cursor to the desired heart rate. Press the ENT key to make a selection.
- 4 Use the arrow keys to move the cursor to the desired blood pressure and then press the ENT key.
- 5 The CuffLink is ready to simulate the selected heart rate and pressure. Press the appropriate key on the unit under test to begin.

## CuffLink Automatic Operation

Use the following procedure to set or change the automatic sequences stored in the CuffLink:

- 1 Move the cursor to the Auto option of the main menu and select Utility by pressing the ENT key.
- 2 Use the arrow keys to move the cursor to the EDIT box. Select sequences to edit and press the appropriate button (F1, F2, F3, etc.).

F1 is assigned to ADULT. In the first screen, answer YES to the Pop-Off test and NO for the remaining. The second and third screens list the sequence of blood pressures and heart rates. Use the arrow keys to move around the list, and use the F4 and F5 keys to change the settings. Set CYCLES for each blood pressure reading.

**Note:**

*When complete with changes, press F3 (STORE) to end the edit session.*

- 3 Use the arrow keys to move the cursor to the NAME box. Select the sequence to be named and press the appropriate button (F1, F2, F3, etc.). Use the arrow keys to move to each character and use the UP and DOWN arrow keys to change the character. When complete, press ENT to end the edit.



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## Overview

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The Model 90207 ABP Monitor has been designed for easy maintenance. If problems develop, use the following information as a problem solving guide.

## Monitor Event Codes

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The 90207 ABP Monitor displays a two-digit event code whenever it is unable to successfully complete a blood pressure measurement. This event code appears as the last digit on the monitor display and is preceded by the letters EC (for example, in EC01, 01 is the event code).

The following list contains a brief description of the event codes that can appear on the monitor display:

- EC00** A) Too much patient movement  
B) Heart rate arrhythmia
- EC01** Cuff not inflated above systole. The monitor will automatically inflate the cuff to a higher pressure on the next attempt.
- EC02** A) Cuff not properly applied  
B) Kinked air hose  
C) Air leak
- EC03** Patient canceled readings by pressing STOP key. No retry attempt is made after an EC03 code.
- EC04** Blood pressure measurement not completed in the maximum time allowed. An occasional EC04 is generally the result of excessive patient movement. Numerous EC04 messages indicate an improperly applied cuff.
- EC05** An occasional EC05 message indicates the monitor's internal safety mechanisms aborted the measurement. If these messages appear frequently, the monitor requires servicing.
- EC07** Clogged input filter.
- EC08** Usually, no data. The cuff may have been taken off.
- EC09** Blood pressure result unreasonable.

The following codes may also appear on the monitor display.

- LLL** Low battery. The battery did not have sufficient power to operate the pump and complete a measurement. No retry attempt is made following an LLL message.
- Lbb** Low backup battery. The blood pressure report will be lost if the lithium battery gets too low.
- FULL** The monitor contains 240 readings and cannot store any additional data.

## Base Station Report Event Codes

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The following list contains the extended event codes that may appear in a blood pressure report. The extended event code digit appears in the first (tens) digit position, for example, 11. The list is grouped according to the monitor event code (if applicable), which would be displayed at the time of the event. The codes are printed as a numeric value in the systolic column, with all other columns printing zero.

Monitor Displays --- EC00	Base Station Report Prints
10	Measurement aborted as the result of excess movement artifact. Frequent "10" messages may indicate an air leak.
20	A) A very large number of movement artifacts B) Heart rate arrhythmia
30	A) Movement artifact at mean arterial pressure B) Heart rate arrhythmia
40	A) Movement artifact at systole B) Heart rate arrhythmia
50	A) Movement artifact at diastole B) Heart rate arrhythmia

Monitor Displays --- EC01	Base Station Report Prints
11	Did not pump above the mean arterial pressure
21	Did not pump above the systolic pressure

Monitor Displays --- EC02	Base Station Report Prints
12	Did not reach initial cuff pressure. The cuff may have been improperly applied or there may be an air leak.
22	Overpressure
32	Overpressure
42	No cuff attached
52	Kinked hose
62	Cuff applied too loosely
72	Kinked hose
82	Kinked hose

Monitor Displays --- EC03	Base Station Report Prints
03	Patient canceled measurement by pressing START/STOP button.

Monitor Displays --- EC04	Base Station Report Prints
04	Measurement not completed within 110 seconds. Occasional EC04 messages may result from excessive patient movement. Frequent ECO4 messages would either indicate an improperly placed cuff or a monitor malfunction which requires service.

Monitor Displays --- EC05	Base Station Report Prints
15	Equipment malfunction. Return it to Spacelabs Medical for service.
25	Unit failed to initialize. Please reinitialize.
35	At least one of the blood pressure or time reading obtained before the event code is erroneous. Interpret all readings with caution.
55	A) Measurement aborted because cuff pressure was too high.
	B) Measurement aborted because measurement has taken longer than two minutes to complete.
65	Equipment malfunction. Return it to Spacelabs Medical for service.
75	Equipment malfunction. Return it to Spacelabs Medical for service.
85	Equipment malfunction. Return it to Spacelabs Medical for service.
95	Cuff pressure baseline out of bounds.

Monitor Displays --- LLL	Base Station Report Prints
16	Low battery prior to start of measurement
26	Low main battery after measurement started

Monitor Displays --- Lbb	Base Station Report Prints
17	Low backup battery
27	Backup battery missing

Monitor Displays --- EC07	Base Station Report Prints
78	Clogged luer filter

Monitor Displays --- EC08	Base Station Report Prints
18	Too few data entries to accurately determine blood pressure
28	Diastole above 200 mmHg
38	Pulse pressure less than 16 mmHg

Monitor Displays --- EC09	Base Station Report Prints
19	Hardware fault (valve open with pump turned ON).
29	Diastolic pressure value cannot be obtained from the data available.
39	Systolic pressure value cannot be obtained from the data available.
49	Mean arterial pressure value cannot be obtained from the data available.
59	Heart rate value cannot be obtained from the data available.
69	Heart rate value cannot be obtained from the data available.

## Problem Solving Checklist

Use this table to diagnose a monitor problem:

*Table 1: Troubleshooting*

Problem	Possible Cause	Solution
<b>Modem indicators incorrect</b>	Modem switch settings are incorrect.	
<b>Monitor display incorrect</b>	No data transfer.	Check modem cable for tight connection.
	Data not retained.	Replace backup battery.
	Low or no power.	Check the batteries for a full charge. If needed, replace or recharge the batteries.
	Can be one of the following: time-out, no reading due to air leak in the system, improper cuff size, or cuff not properly attached to the monitor.	Isolate cause and correct.
	Bad phone line.	Have phone company check out line.
	Incorrect configuration of the phone system.	Verify modem configuration with the phone company and with Spacelabs Medical Technical Support Department.
<b>Monitor displays “LLL” and alarm sounds.</b>	Low main battery condition.	Turn OFF monitor immediately. Replace batteries within 60 seconds after removal to continue monitoring.
<b>Monitor displays event code “Lbb” during self-testing.</b>	Low backup battery condition.	Replace backup battery before continuing.
<b>Cuff too tight</b>	Cuff placed on the patient too tightly.	Reposition the cuff.
	Air pump staying on too long.	Return the unit to Spacelabs Medical for service.
<b>Cuff is too loose when inflated.</b>	Cuff is placed on the patient too loosely.	Reposition the cuff.
	Air pump is not staying on long enough.	Return the unit to Spacelabs Medical for service.
<b>Monitor will not initialize.</b>	Password is incorrect.	To delete old password, take both lithium and AA batteries out and wait 3 to 5 minutes. Reinstall batteries and initialize monitor.

## Contents

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## 90207 Field Replaceable Parts Lists

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Description	Part Number
90207, PCB assembly	672-0085-xx
Bracket, pump mounting	407-0099-01
Case, battery cover	437-0029-01
Case, cover	437-0027-02
Case, main body	437-0028-xx
Cushion, motor/pump	348-0064-00
Diode, photo, OP293A, 16 mw	152-0050-00
Kit, case 90207	040-0321-00
Label, communication, English	334-0251-02
Label, communication, German	334-0322-03
Label, communication, French	334-0320-02
Label, opr inst/screw cover, English	334-1285-00
Label, opr inst/screw cover, German	334-1281-00
Label, opr inst/screw cover, French	334-0319-01
Label, serial number, English	334-0922-00
Label, serial number, German	334-0237-01
Label, serial number, French	334-0223-01
Lithium battery, 3 V	146-0008-00
Manifold assembly, 90207	650-0041-01
ON/OFF switch	260-0024-00
Panel, switch, membrane, front, Int'l	333-0158-01
PCB, flex BD, 90207	388-0195-02
Auxillary PCBA	670-1295-00
Photo transistor	152-0026-00
Pump assembly, 3 V, 3700 RPM	119-0060-05

Description	Part Number
Reed switch	260-0036-00
Shield, static protection	337-0085-01
Spring, normal double battery	214-0129-02
Spring, reverse/double battery	214-0125-02
Spring, single/conical Battery	214-0122-00
Spring, single/flat battery	214-0126-01
Transducer, pressure, 0-15 PSI, SC7541	117-0006-00
Tubing, .078 ID (10 feet)	166-0007-00
Tubing, .104 ID (10 feet)	255-0004-00A
Valve, air, 4.0 V, 160 ohm	214-0128-00

## Drawings

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Title	Part Number	Drawing #
PCBA, Main Board	670-0303-10	1 (5 sheets)
Display Board Schematic	670-0302-00	2 (1 sheet)
IR Board Schematic	670-0304-02	3 (1 sheet)
PCBA, Main Board	670-0303-12	4 (2 sheets)

### Caution






















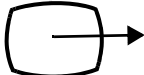


**Observe precautions for handling electrostatic-sensitive devices!**





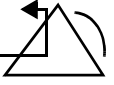
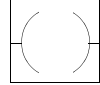

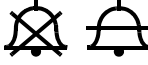
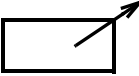
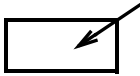














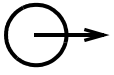
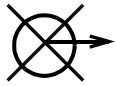
**Note:**

- *Never touch electrostatic-sensitive electronic components without following proper anti-static procedures, including the use of an ESD wrist band and mat. An electrostatic discharge from your fingers can permanently damage electronic components.*
- *All static-sensitive electronic components are packaged in static-shielding bags. Retain the bag for repackaging the component should you need to store it or return it to Spacelabs Medical for any reason.*

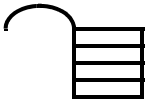











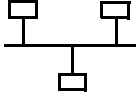

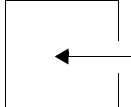
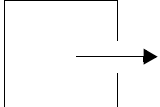





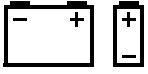


# Symbols



















The following list of international and safety symbols describes all symbols used on Spacelabs Medical products. No one product contains every symbol.









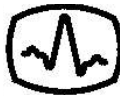



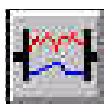



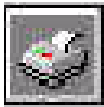



Symbol	Description	Symbol	Description
	HELP Key		Keyboard Connection
	SPECIAL FUNCTIONS Key		Mouse connection
	RECORD Key		START/STOP Key
	NORMAL SCREEN Key		START/STOP
	MONITOR SETUP Key		STOP or CANCEL Key
	ALARMS Key		CONTINUE Key
	PREVIOUS MENU Key		ENTER Key
	ON — Power Connection to Mains		OFF — Power Disconnection from Mains
	ON Position for Push Button Power Switch		OFF Position for Push Button Power Switch
	On Direction		ON/OFF
	Television; Video Display		Video Output
	ON — Part of the Instrument Only		OFF — Part of the Instrument Only

Symbol	Description	Symbol	Description
	Stand-by		STAND-BY Key
	PAUSE or INTERRUPT		Slow Run
	Reset		Power Indicator LED
	Alarm		Temporary Shut Off of Alarm Tone or Screen Indicators
	Indicator — Remote Control		Indicator — Local Control
	PRINT REPORT Key		Indicator — Out of Paper
	Partial ON/OFF		Recorder Paper
	Normal Screen		Return to Prior Menu
	Clock/Time Setting Key		TREND/TIMER Key
	HELP (Explain Prior Screen) Key		Keypad
	Activate Recorder for Graphics		Indoor Use Only
	START (NIBP) Key		Auto Mode (NIBP)
	Output		No Output (Terminated)

Symbol	Description	Symbol	Description
	Data Input/Output		Input/Output
	Input		Reset
	Menu Keys		Waveform/Parameter Keys
	Monitor Setup Select Program Options		Set Initial Conditions Menu
	Access Special Function Menu		Return Unit to Monitor Mode
	Serial Port 1		Serial Port 2
	External marker push button connection		SDLC Port
	Arterial Pulse		Electrocardiograph or Defibrillator Synchronization
	Gas Exhaust		Foot Switch
	Enlarge, Zoom		Delete
	PCMCIA Card		Event
	Keep Dry		Fragile; handle with care
	Environmental Shipping/Storage Altitude Limitations		This Way Up
	Environmental Shipping/Storage Temperature Limitations		Environmental Shipping/Storage Humidity Limitations

Symbol	Description	Symbol	Description
	Open Padlock		Closed Padlock
	Down Arrow		Up Arrow
	Hard Drive		Power Indicator LED
	Antenna		Mermaid Connector
	Microphone		Omnidirectional Microphone
	Audio Output, Speaker		Activate Telemetry Recorder
	Network Connection		Universal Serial Bus
	Gas Sampling Port		Gas Return Port
	Remote Alarm; Nurse Alert		Nurse Call
	Battery Status		Low Battery
	Battery Replace only with the appropriate battery.		Replace only with the appropriate battery. (+ / - signs may be reversed)
	All batteries should be disposed of properly to protect the environment. Lithium batteries should be fully discharged before disposal. Batteries such as lead-acid (Pb) and nickel-cadmium (Ni-Cd) must be recycled. Please follow your internal procedures and or local (provincial) laws regarding disposal or recycling.		Caution - hazardous voltages. To reduce risk of electric shock, do not remove the cover or back. Refer servicing to a qualified service personnel (U.S.A.).  DANGER - High Voltage (International)

Symbol	Description	Symbol	Description
	Protective Earth Ground		Functional Earth Ground
	Replace Fuse Only as Marked		Fuse
	Power supply jack polarity. (+ / - signs may be reversed)		Equipotentiality Terminal
	Alternating Current		Direct Current
	Both Direct and Alternating Current		AC/DC Input
A	Amperes	Hz	Hertz
V	Volts	W	Watts
	IEC 601-1 Type B equipment. The unit displaying this symbol contains an adequate degree of protection against electric shock.		Class II Equipment
	IEC 601-1 Type BF equipment which is defibrillator-proof. The unit displaying this symbol contains an F-type isolated (floating) patient-applied part which contains an adequate degree of protection against electric shock, and is defibrillator-proof.		IEC 601-1 Type BF equipment. The unit displaying this symbol contains an F-type isolated (floating) patient-applied part providing an adequate degree of protection against electric shock.
	IEC 601-1 Type CF equipment. The unit displaying this symbol contains an F-type isolated (floating) patient-applied part providing a high degree of protection against electric shock, and is defibrillator-proof.		IEC 601-1 Type CF equipment. The unit displaying this symbol contains an F-type isolated (floating) patient-applied part providing a high degree of protection against electric shock.
	Loop Filter		Adult NIBP

Symbol	Description	Symbol	Description
	ETL Laboratory Approved		Canadian Standards Association Approved
	Risk of Explosion if Used in the Presence of Flammable Anesthetics		Operates on Non-Harmonized Radio Frequencies in Europe
<b>Note</b>	Note		Attention - Consult Operations or Service Manual for Description
<b>WARNING</b>	Warning About Potential Danger to Human Beings	<b>CAUTION</b>	Caution About Potential Danger to a Device
	Noninvasive Blood Pressure (NIBP), Neonate		Fetal Monitor Connection (Analog)
	Fetal Monitor Connection RS232 (Digital)		Physiological Monitor Connection RS232 (Digital)
	Happy Face		Sad Face
	Magnifying Glass		Compression
	File Cabinet		List of Rooms
	Arrows		Printer
	Recycle		Service Message
	Radio transmitting device; elevated levels of non-ionizing radiation		

Abbreviations used as symbols are shown below.

Symbol	Description	Symbol	Description
<b>1 - 32</b>	Access Codes 1 Through 32	<b>AIR</b>	Air
<b>ANT 1</b> <b>ANT 2</b>	Diversity Antenna System 1 Diversity Antenna System 2	<b>Arr1</b> <b>ArrNet2</b>	Arrhythmia Net 1 Arrhythmia Net 2
<b>CH</b> <b>ch</b>	EEG, EMG, or ECG Channel EEG Channels - CH1, CH2, CH3, CH4 EMG Channel - CH5	<b>cmH<sub>2</sub>O</b>	Centimeters of Water
<b>C.O.</b> <b>CO</b> <b>co</b>	Cardiac Output	<b>DIA</b> <b>dia</b>	Diastolic
<b>ECG</b> <b>ecg</b>	Electrocardiogram	<b>EEG</b> <b>eeg</b>	Electroencephalogram
<b>EMG</b> <b>emg</b>	Electromyogram	<b>ESIS</b>	Electrosurgical Interference Suppression
<b>EXT</b>	External	<b>FECG</b>	Fetal Electrocardiogram
<b>FHR1</b> <b>FHR2</b>	Fetal Heart Rate, Channel 1 Fetal Heart Rate, Channel 2	<b>GND</b> <b>gnd</b>	Ground
<b>HLO</b> <b>hlo</b>	High-Level Output	<b>Multiview</b>	Multi-Lead Electrocardiogram
<b>NIBP</b> <b>nibp</b>	Noninvasive Blood Pressure	<b>N<sub>2</sub>O</b>	Nitrous Oxide
<b>O<sub>2</sub></b>	Oxygen	<b>PRESS</b> <b>press</b> <b>PRS</b>	Pressure
<b>RESP</b> <b>resp</b>	Respiration	<b>SDLC</b>	Synchronous Data Link Control
<b>SPO2</b> <b>SpO2</b> <b>SpO<sub>2</sub></b> <b>SaO<sub>2</sub></b>	Arterial Oxygen Saturation as Measured by Pulse Oximetry	<b>SVO2</b> <b>SvO<sub>2</sub></b> <b>SvO<sub>2</sub></b>	Mixed Venous Oxygen Saturation

Symbol	Description	Symbol	Description
<b>SYS</b> <b>sys</b>	Systolic	<b>T1</b> <b>T2</b> <b>T3</b> <b>T4</b>	Temperature 1 Temperature 2 Temperature 3 Temperature 4
<b>TEMP</b> <b>temp</b>	Temperature	<b>UA</b>	Uterine Activity or Umbilical Artery
<b>VAC</b>	Vacuum Connection		

# Appendix A — Electromagnetic Compatibility

## Contents

Electromagnetic Emissions .....	1
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## Electromagnetic Emissions

**Note:**

*The 90207 ABP monitor has been tested under laboratory conditions and is suitable for use in all establishments, including domestic establishments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes. The customer, or user, of the module should ensure that it is used in such an environment.*

Emission Test	Compliance	Electromagnetic Environment
RF emissions <b>CISPR 11</b>	Group 1 Class B	The ABP monitor uses RF energy only for internal function. Therefore, RF emissions are very low and are not likely to cause any interference in nearby electronic equipment

## Electromagnetic Immunity

**Note:**


*The ABP monitor is intended for use in the electromagnetic environment specified below. The customer, or user, of the module should ensure that it is used in such an environment.*

Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment
Electrostatic discharge (ESD) <b>IEC 61000-4-2</b>	±6 kV contact ±8 kV air	6 kV contact 8 kV air	Floors should be wood, concrete, or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.

## Frequency Separation Distances

**Note:**

*The ABP monitor is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer, or user, of the module can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the module, as recommended below, according to the maximum output power of the communications equipment.*

Recommended Separation Distances Between Portable and Mobile RF Communications Equipment and the Monitor (Always evaluate electronic equipment on site before use.)			
Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment
Radiated RF <b>IEC 61000-4-3</b>	3 V/m 80 MHz to 2.5 GHz	3 V/m 1 kHz sine 80% AM	<p>Portable and mobile RF communications equipment should be used no closer to any part of the monitor, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.</p> <p><b>Recommended separation distance:</b></p> $d = \left[ \frac{3.5}{V_1} \right] \sqrt{P}$ <p>150 kHz to 80 MHz</p> $d = \left[ \frac{3.5}{E_1} \right] \sqrt{P}$ <p>80 MHz to 800 MHz</p> $d = \left[ \frac{7}{E_1} \right] \sqrt{P}$ <p>800 MHz to 2.5 GHz</p> <p>Where <math>P</math> is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer, and <math>d</math> is the recommended separation distance in meters (m).</p> <p>Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey,* should be less than the compliance level in each frequency range.**</p> <p> Interference may occur in the vicinity of equipment marked with the following symbol. IEC 60417-5140: Non-ionizing electromagnetic radiation</p>
<p>* Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast, and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the monitors are used exceeds the applicable RF compliance level above, the monitors should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the monitors.</p> <p>** Over the frequency range 150 kHz to 80 MHz, field strengths should be less than <math>[V_1]</math> V/m.</p>			

Rated Maximum Output Power of Transmitter (watts)	Separation Distance According to Frequency of Transmitter (meters)		
	150 kHz to 80 MHz	80 MHz to 800 MHz	800 MHz to 2.5 GHz
0.01	0.02	0.02	0.04
0.1	0.06	0.06	0.1
1	0.2	0.2	0.4
10	0.6	0.6	1.1
100	1.8	1.8	3.5
<b>Note 1:</b> At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies. <b>Note 2:</b> These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects, and people.			

