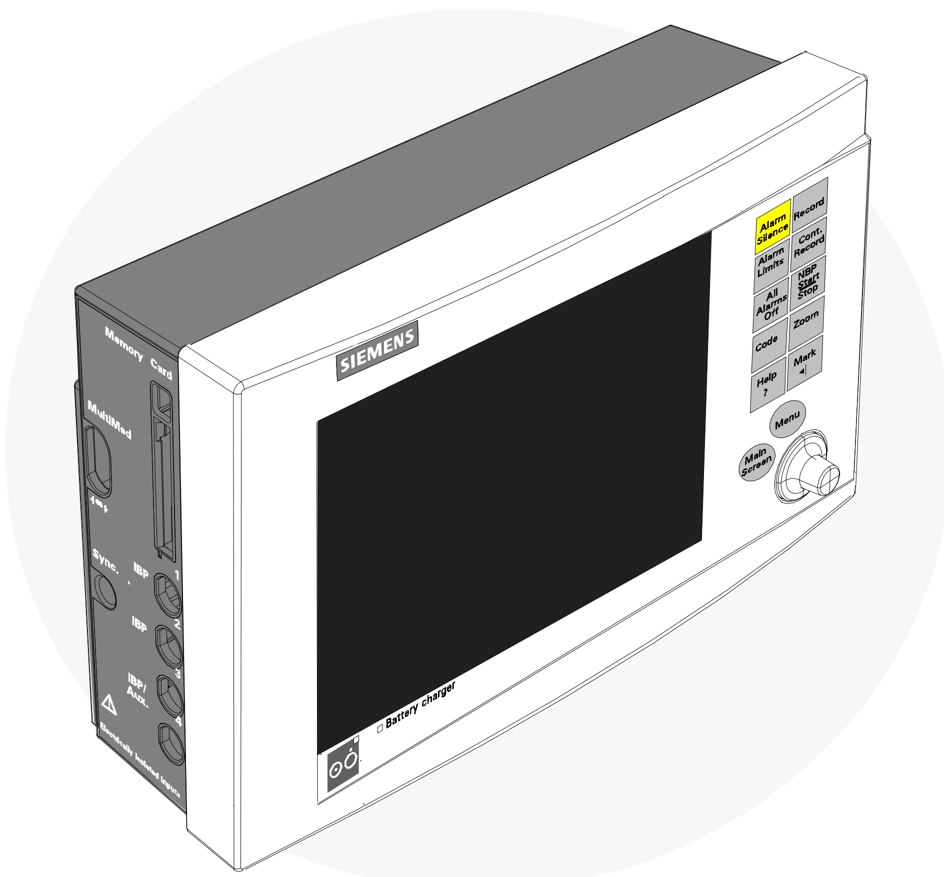
SIEMENS

SC 9000 Patient Monitors
Service Manual



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ADVISORY

Siemens is liable for the safety of its equipment only if maintenance, repair, and modifications are performed by authorized personnel, and if components affecting the equipment's safety are replaced with Siemens spare parts.

Any modification or repair not done by Siemens personnel must be documented. Such documentation must:

- be signed and dated
- contain the name of the company performing the work
- describe the changes made
- describe any equipment performance changes.

It is the responsibility of the user to contact Siemens to determine warranty status and/or liabilities if other than an authorized Siemens technician repairs or makes modifications to medical devices.

Table of Contents

Chapter 1 - Introduction / Brief Operating Instructions

Chapter 2 - Functional Description

Chapter 3 - Repair

Chapter 4 - Calibration / Functional Verification

Chapter 5 - Troubleshooting

Appendix A - Replacement Parts

Appendix B - Connector Pinouts

Appendix C - Diagnostic Messages

Appendix D - Functional Verification Checklist

Chapter 1

Introduction / Brief Operating Instructions

1.1 Introduction

This Manual is intended to serve as a source of technical information for qualified personnel to use in servicing SC9000 Monitors and associated peripheral devices. In light of the state-of-the-art technology used in the manufacture of Siemens' equipment, proprietary nature of the software, and specialized equipment required for replacement of most individual parts, Siemens policy is for SC9000 monitors and peripheral modules specifically related to the SC9000 to be serviced only to the field-replaceable subassembly level. Replacement of components other than those listed in Appendix A, Spare/Exchange Parts, should be performed only at Siemens service depots.

1.2 Overview

The SC9000 monitor has been designed to function as both a portable and a stationary monitor with equal ease. It has an internal battery, as well as provision for a larger-capacity battery module for extended operation as a portable monitor. For stationary operation near a bedside, the monitor is placed on a specially designed passive docking station attached to a shelf, wall, or IV pole that securely locks it into place. While on the docking station, the monitor is powered by an external power supply that also charges the monitor's internal battery and the battery module. In addition, the docking station provides audio, video and data signal connection to the local network, a 15” display/control unit, and a recorder. Employing a "pick-and-go" concept, the monitor is simply picked up off of the docking station to return it to portable operation, with no interruption in patient monitoring.

The major components of the SC9000, as illustrated in Figure 1-1, are the Base Unit, MultiMed Pod, 4-Pressure Pod or 2-Pressure Pod, $etCO_2$ cartridge, NBP cartridge, external battery module, Recorder, CPS (Communiction/Power Supply), 15” display/control unit, and docking station. An auxiliary docking station is also available for mounting the Recorder in close proximity to the SC9000 in a standalone installation.

1.2.1 Base Unit

The standard SC9000 Base Unit has a color LCD display and an internal speaker, and employs both fixed-keys and a rotary knob for user input.

1.2.2 MultiMed Pod

The 5-electrode MultiMed pod provides up to 7 leads, including 1 chest lead (V), and impedance respiration (from one of three possible leads). The pod also provides for SpO_2 and one temperature.

1.2.3 4-Pressure Pod

The 4-pressure pod provides four invasive pressures, two temperatures, and cardiac output (blood and injectate) temperatures. It has three keys -- C.O. Start, Wedge and Zero All IBP. The "A", "B", "C", and "D" markings on the front of the pod correspond to the similarly labeled transducer connectors on the back. The LCD displays provide pod labels -- 4 characters for each transducer.

1.2.4 2-Pressure Pod

The 2-pressure pod is similar to the 4-pressure pod except that it provides only two invasive pressures and has only “A” and “B” markings.

1.2.5 R50 Recorder

The R50 Recorder connects to the SC9000 via the CPS in a network installation or an interface plate in a standalone installation. It prints on 50mm wide paper, and has three control keys -- Start Cont., Alternate Speed, and Stop.

1.2.6 $etCO_2$ Cartridge

The $etCO_2$ cartridge provides airway and sidestream CO_2, and has no keys.

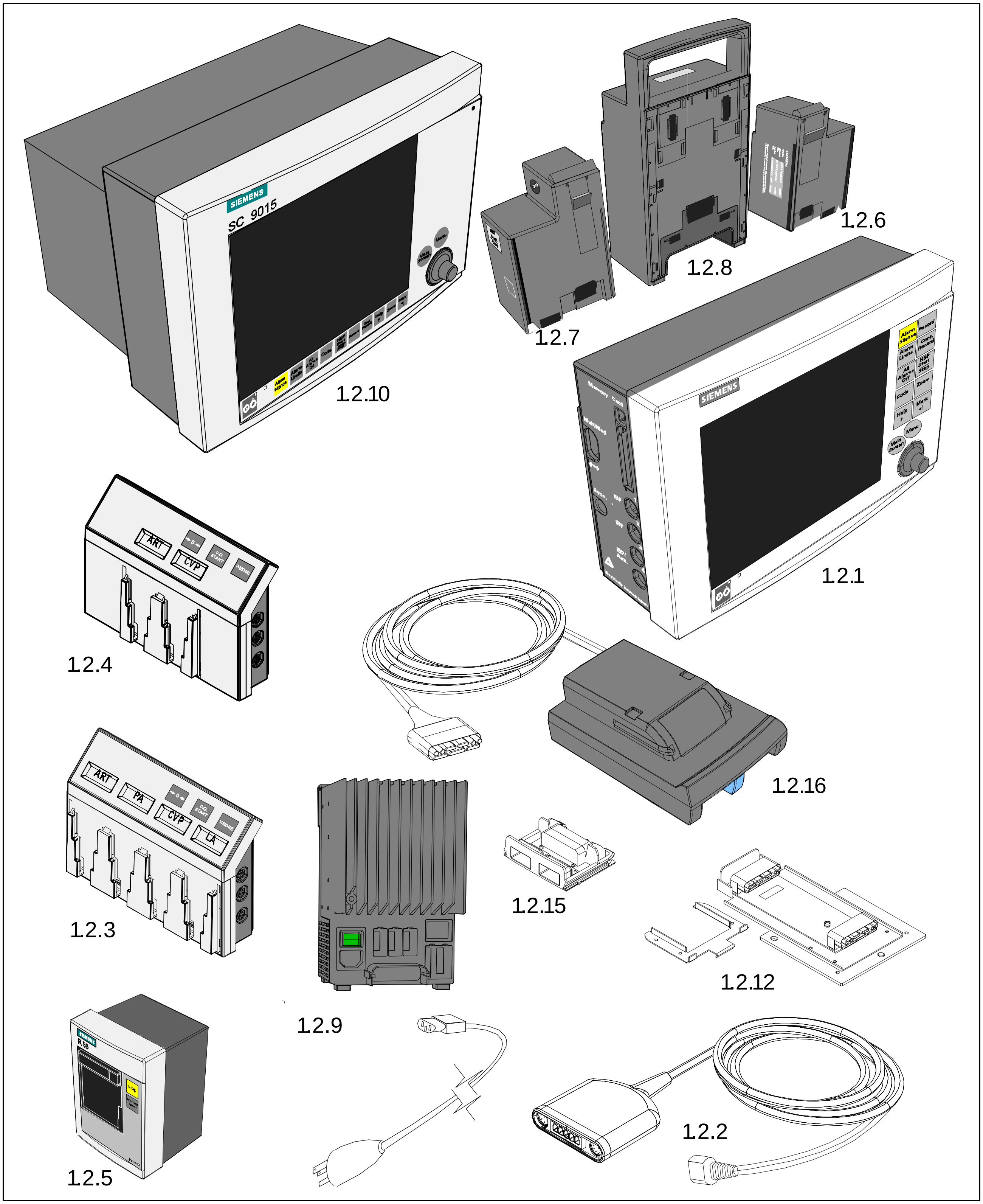

Figure 1-1 SC9000 System Components

1.2.7 NBP Cartridge

The NBP cartridge supplies cuff pressure for non-invasive blood pressure measurement, and is equipped with a Start/Stop key that operates in parallel with the Start/Stop key on the front panel of the SC9000.

1.2.8 Battery Module

The external battery module attaches to the "power" slot on the back of the SC9000 Base Unit, and has a fixed handle for carrying the SC9000. It has been designed to allow the user to smoothly insert/remove the battery from the base unit, with a locking mechanism that prevents the battery from being accidently disengaged from the base unit while it is being carried. The battery pack has an LCD bar display indicating the remaining charge in the external pack.

1.2.9 CPS

1.2.9.1 SIRENET

The SIRENET CPS (Communication/Power Supply) connects to the SC9000 Base Unit either via the Docking Station or mounted directly in the power slot on the back of the base unit and connected via a bridge plate. The SIRENET CPS performs the following functions:

- powers the SC9000 from an AC power source
- provides power to charge both the internal SC9000 base unit battery and external battery module
- provides SIRENET connectivity
- provides ALARM OUT
- provides remote display connectivity via AV cable
- provides connection capability to the R50 recorder

1.2.9.2 INFINITYNET

The INFINITYNET CPS (Communication/Power Supply) connects to the SC9000 Base Unit either via the Docking Station or mounted directly in the power slot on the back of the base unit and connected via a bridge plate. The INFINITYNET CPS performs the following functions:

- powers the SC9000 from an AC power source
- provides power to charge both the internal SC9000 base unit battery and external battery module
- provides INFINITY Network connectivity
- provides ALARM OUT
- provides remote display connectivity via AV cable
- provides connection capability to the R50 and R100 Recorders
- provides MIB and CANBUS connectivity

1.2.10 Remote Display

1.2.10.1 SC 9015

The SC 9015 Remote Display/Control unit connects to the CPS via an AV cable. It is powered separately from the CPS by its own line cord, and includes the following hardware:

- 15” color VGA 640 x 480 screen (driven by graphics hardware in the base unit)
- ambient light sensor (for controlling screen intensity)
- speaker (driven by an audio tone generator on the base unit)
- fixed keys and a rotary knob for user input
- power LED

1.2.10.2 Passive Remote Display

The passive remote display unit connects to the CPS via an AV cable. It is powered separately from the CPS by its own line cord, and includes the following hardware:

- 15” color VGA 640 x 480 screen (driven by graphics hardware in the base unit)
- ambient light sensor (for controlling screen intensity)
- speaker (driven by an audio tone generator on the base unit)
- power LED

1.2.11 Bridge Plate

The bridge plate is used to provide monitor to CPS connection in an installations that does not use a docking station. The CPS mounts directly on the back of the SC9000 in place of the external battery module. The bridge plate connects the monitor directly to the CPS.

1.2.12 Data Card

The SC9000 Data Card (not shown) serves two primary purposes -- transfer configuration data from one CPS to another and upload diagnostic logs from a monitor. The Data Card is equipped with an internal battery that must be recharged for a period of 12 hrs. every six months. Procedures for charging the Data Card are included in documentation supplied with each card.

1.2.13 PSL

The PSL (not shown) plugs directly into the PSL connector on the back of the SC9000, for operating the monitor in a stand-alone configuration.The PSL provides the following:

- powers the SC9000 from an AC power source
- provides power to charge both the internal SC9000 base unit battery and external battery module

1.2.14 Interface Plate

The Interface Plate provides connectivity to the R50 Recorder, remote alarm out, SC9015 Remote Display/Control (or Passive Remote Display) when the monitor is in a standalone configuration powered by a PSL.

1.2.15 Docking Station

A docking station is a passive device that provides a sturdy mount for the SC9000 Base Unit while supporting the "pick and go" concept. The docking station mounts near a bedside, attached to a shelf, wall, or an IV pole, and provides pass-through for the signals from a SC9000 Base Unit. A second docking station supports peripheral devices such as the R50 Recorder.

1.3 Service Policy

The design of the SC9000 facilitates repair to the replaceable subassembly (e.g., PCB, module) or selected component (e.g., rotary knob, connectors) level in the field, after the monitor has been declared “field-serviceable” (PC Boards are NOT field repairable). The repair philosophy for any unit is to exchange specified subassemblies. A Service PC is used to identify a faulty subassembly that is then replaced. A listing of replaceable items is given in Appendix A.

1.4 Related Documentation

- Operating Instructions for the installed software version
- Hardware Installation instructions
- Service Setup Instructions
- Data Card Application Instructions

1.5 Cleaning

Contact with methyl alcohol, chlorine bleach, Cidex, acetone, Hibitane, iodine, adhesive tape remover pads, anesthetic agents, or body fluids does not damage or cause discoloration of any component case of an SC9000 installation. Clean Base Unit, pods, cartridges, and cables using a 95% solution of isopropyl alcohol.

NOTE: *Bac solution mars the finish of the monitor case.*

1.6 Technical Data

A complete set of technical data is given in the Operating Instructions (User Guide) for the installed software version.

1.7 Brief Operating Instructions

This section provides a brief overview of SC9000 monitor controls to assist technical personnel in servicing and testing procedures. For detailed operating instructions and additional information, consult the SC9000 Monitor Operating Instructions and supplements for the installed software version.

1.7.1 SC9000 Base Unit Controls

Control of all SC9000 functions is via fixed keys that have tactile feedback, and a rotary knob for selecting from on-screen menus. Turning the rotary knob locates different menu items, and pressing the knob in selects the item. Depending on the item selected, pressing the knob in may either bring up another menu or initiate an action. "Ghosted" items cannot be selected.

The SC 9015 Remote Display/Control Unit has an identical set of keys and display knob, that mimic the action of those on the SC9000 Base Unit. Except for the ON/OFF key, the SC9000 can be operated from either the base unit or the SC 9015 Remote Display/Control unit.

1.7.2 Cartridge, Pod, and Peripheral Device Controls

Individual cartridges, pods, and peripheral devices (such as the recorder) also have fixed keys that control specific aspects of their operation. Refer to the SC9000 Monitor Operating Instructions for the specific key functions.

1.8 Passwords

The SC9000 system has two kinds of basic password protection -- clinical password, and service password. Clinical and service passwords are entered via selections on a keypad that appears whenever a password-protected function is selected. To enter a password, turn the rotary knob to highlight a number and then press in on the knob to enter the number. When all numbers of the password have been entered, turn the knob to highlight "Accept," and press in on the knob.

1.8.1 Clinical Password

The clinical password is available to authorized supervisory personnel at the clinical site as well as to service personnel.

1.8.2 Service Password

The service password is available only to authorized service personnel.

1.9 Menus

1.9.1 Main Menu

The Main Menu uses a three column layout for menu navigation: Level 1 = main selection list, Level 2 = workspace A, and level 3 = workspace B. Selecting any function category on Level 1 of the Main Menu brings up a list of selectable related functions and menus in Level 2. Selecting a function in Level 2 produces a similar result in Level 3.

Press the MENU fixed-key to display the MAIN screen with an overlay of the Main Menu.

1.9.2 Service Menu

The Service Menu is accessed via the Monitor Options selection under the Monitor Setup function on the Main Menu. To access the Service menu and related functions,

1. Select Monitor Setup on Level 1, then select Biomed on Level 2, and then select Service on Level 3.
2. Input the service password.

   NOTE: The Service Menu provides access to the following (may vary with software version):

   - Language selection
   - Regulation
   - Alarm Sounds

- Network control
- Transport Brightness
- Line frequency setting
- Restore factory defaults
- Copy setups to card
- Copy setups to monitor
- Install Software
- Locked Options
- Waveform Simulator

1.9.2.1 Install Software Menu

Software and languages for the SC9000 Monitor and CPS are installed from a memory card via the SC9000 base unit memory card reader. A memory card contains a specific number of copies of the software program, which are each good for only one-time use.

1.10 Install Monitoring Software

1.10.1 Normal Software Installation

1. Insert the SC9000 PCMCIA card into the base unit card reader and power the monitor on.
2. To install additional options or upgrade software in monitors that already contain valid software, insert the SC9000 PCMCIA Card into the base unit card reader, access the Install Software Menu and select the Install Monitoring Software function.

   NOTE: In either case, the installation identification and notification steps are the same. The monitor repeatedly sounds a tone while software loading is in progress. When software loading is completed, the monitor powers itself down and sounds the piezo tone.
3. Repower the monitor on, and install hospital information.

1.10.2 Use of Boot Jumper

Use this procedure ONLY as a backup, in the event the normal procedure should fail to complete properly. The boot switch is located behind the left-hand side panel at the top right of the card slot (see Figure 1-4). The panel is secured to the rear housing by eight locking tabs and a latch.

1. Switch monitor power OFF.
2. Remove Left Side Panel as follows:
   - Insert PCMCIA card into memory card slot to force ejection button out.
   - Remove ejection button cover. To remove the cover, grasp the front and back sides of the button cover between your thumb and forefinger, squeeze the covers lightly, and carefully rock the cover off of the shaft in the direction of the arrow in Figure 1-2.

   Warning: The button cover has nubs that grip grooves in the top and bottom sides of the shaft, as illustrated in Figure 1-2. Grasping the button by the top and bottom sides tends to increase the effectiveness of the nubs, increasing the force required to remove it. Excessive force can pull the shaft completely out of the ejector mechanism, requiring depot repair of the monitor.

   - Push ejection shaft back in, and remove PCMCIA card.

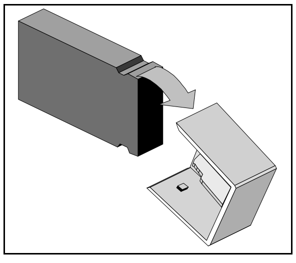

Figure 1-2Button Cover

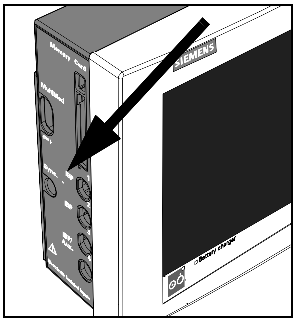

Figure 1-3Left Side-Panel

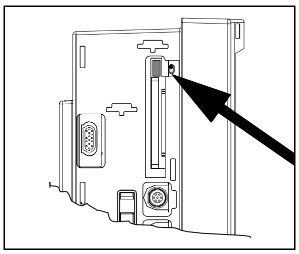

Figure 1-4Boot Switch

- Press firmly on the dot on the lower center of the panel between IBP1 and IBP 2 (see arrow in Figure 1-3), to release the latch.
- While pressing, slide the panel downward to release the locking tabs, and remove it from the monitor.

3. Set boot switch ON (down position). See arrow in Figure 1-4.
4. Insert PCMCIA card into memory slot.

   NOTE: The card can be fully inserted in only one orientation, because of the keyed channels on the end of the card. The card can be damaged if it is forced into the slot. Insert the card firmly, but do NOT attempt to force the card into the slot. The eject button is pushed out when the card is properly seated. Be sure that Write Protect on the card is set to OFF.
5. Switch monitor power ON. Wait while software downloads (≈1.5 - 2min.).

   NOTE: The monitor repeatedly sounds a tone while software loading is in progress. When the software loading process has completed, the monitor powers itself OFF and the Piezo sounds.

   Warning: Do NOT remove the PCMCIA card until instructed to do so.
6. Reset boot switch to OFF (up position).
7. Switch power ON.
8. Enter your name, customer’s country code and site number, and then select Continue.
9. Remove the PCMCIA card.

   NOTE: The Monitor emits a loud high-pitched tone if rebooted with the switch ON and the PCMCIA card removed.
10. Reinstall left side panel and ejection button cover.
11. If upgrading existing software, affix a new S/W version label over existing label near top of Memory Card slot on left side panel.
12. Re-setup the monitor as required. (Refer to Service Setup Instructions.)

1.11 Data Card Application

1.11.1 Introduction

The SC9000 Data Card serves two primary purposes -- to transfer configuration data from one CPS to another and to upload diagnostic logs from a monitor. The Data Card is equipped with an internal battery that must be recharged for a period of 12 hrs. every six months.

Bedside Monitors are shipped with software installed. But the configuration of the monitor is established at the customer site, and in networked monitors is stored in the CPS. If more than one CPS at a customer site is to be configured identically, the Data Card can be used to transfer the configuration, rather than requiring each CPS to be set up independently.

In the event of a monitor malfunction, the diagnostic logs can help factory engineers identify possible sources of error and make corrective modifications in subsequent software or hardware releases if required.

1.11.2 Configuration download procedure

In general, the procedure is to completely set up one monitor, save the setup to the CPS, and then transfer the setup to the Data Card. The configuration stored in the Data Card can then be used to setup other CPSs.

1. With no Data Card inserted and monitor on docking station connected to CPS, adjust settings for monitor exactly as required by customer.
2. Review configuration with appropriate customer personnel before proceeding.
3. Press Menu key, and use rotary knob to select Save/Restore → Save Setup.
4. Enter clinical password, 375, and select Accept.
5. Highlight setup to be saved, and press rotary knob in to save selection to CPS.

   NOTE: Only the Default configuration supports “Pick and Go.”
6. Wait for message “New Setup Saved.”
7. Repeat steps 1. through 6. for optional setups as required, and select Rename Setup in Biomed menu to name each setup in accordance with site requirements.
8. With MAIN screen displayed on monitor, insert and firmly seat Data Card into memory slot.

   NOTE: The card can be fully inserted in only one orientation, because of the keyed channels on the end of the card. The card can be damaged if it is forced into the slot. Insert the card firmly, but do NOT attempt to force the card into the slot. The eject button is pushed out when the card is properly seated. Be sure that Write Protect on the card is set to OFF.
9. Press Menu key, and use rotary knob to select Monitor Setup → Biomed → Service
10. Enter Service password, 4712, and select Accept.
11. Select More → “Copy Setups to Card.”
12. Select “Copy All.”
13. Wait for message “Memory Card Tansfer Complete.” Then press Main Screen key and remove Data Card from monitor.
14. Insert card in next monitor connected to a CPS to be identically configured.
15. Press Menu key, and use rotary knob to select Monitor Setup → Biomed → Service
16. Enter Service password, 4712, and select Accept.
17. Select More → “Copy Setups to Monitor.”

    NOTE: In actuality, this copies the setups to the CPS, which in turn reconfigures the setup of the monitor when “Restore Setups” function is invoked.
18. Select “Replace All.”
19. Wait for message “Memory Card Tansfer Complete.” Then press Main Screen key and remove Data Card from monitor.
20. Press Menu key, and use rotary knob to select Save/Restore → Restore Setup.
21. Select “Default” → “Patient and Monitor Settings.”
22. Repeat steps 14. through 21. until all CPSs to be identically configured have been set up.

1.11.3 Diagnostic Log Upload Procedure

This procedure can upload the diagnostic logs from approximately 10 to 16 monitors, depending on the size of the individual logs. Assure that the Write/ Protect switch on the Data Card is set to the Write position.

1. With MAIN screen displayed on monitor, insert and firmly seat Data Card into memory slot.
2. Press Menu key, and use rotary knob to select Monitor Setup → Biomed → Logs
3. Select “Copy All Logs.”
4. Remove Data Card from monitor, and repeat steps 1, 2 and 3 for next monitor from which logs are to be uploaded.

1.11.4 Charging Data Card Battery

The battery in the Data Card must be recharged for a period of 12 hours approximately every six months. Any SC 9000 monitor powered by a CPS can be used to recharge the Data Card. Insert the card into the SC9000 monitor, and allow it to remain in the monitor for 12 hours.

1.11.5 Returning Data Card

Return the Data Card (in its preaddressed return case when possible), to:

Siemens Medical Systems, Inc.

Electromedical Systems Division

16 Electronics Avenue

Danvers, MA 01923

U.S.A.

Att: SC 9000 Project Manager

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Chapter 2

Functional Description

2.1 Introduction

The hardware architecture of the SC9000 monitor is based on a single processor design, the 68040 with on-board cache. There are other specialized processors in the SC9000 monitor such as graphics and DSPs, but processing is always centralized whenever possible. There are three major bus structures within the system; the local CPU bus, the peripheral bus, and the REMOTE COMM bus (see Fig. 2-1). These buses operate at different speeds and efficiency. The peripheral bus and the REMOTE COMM bus both have multiple bus masters and have common memory to allow exchange between I/O devices.

The REMOTE COMM bus is special in that it may be connected and disconnected without causing a monitor fault. This allows monitors to be moved to different locations within the hospital and to connect to multiple REMOTE COMM links without interruption of monitoring. The traditional central station alarm function of alarming when the patient monitor is suddenly disconnected from the network is modified in this system by insuring that a disconnect is intentional. This is done by requiring a double fault to allow a disconnect. The connect and disconnect function of the monitor is advertised as "Pick and Go".

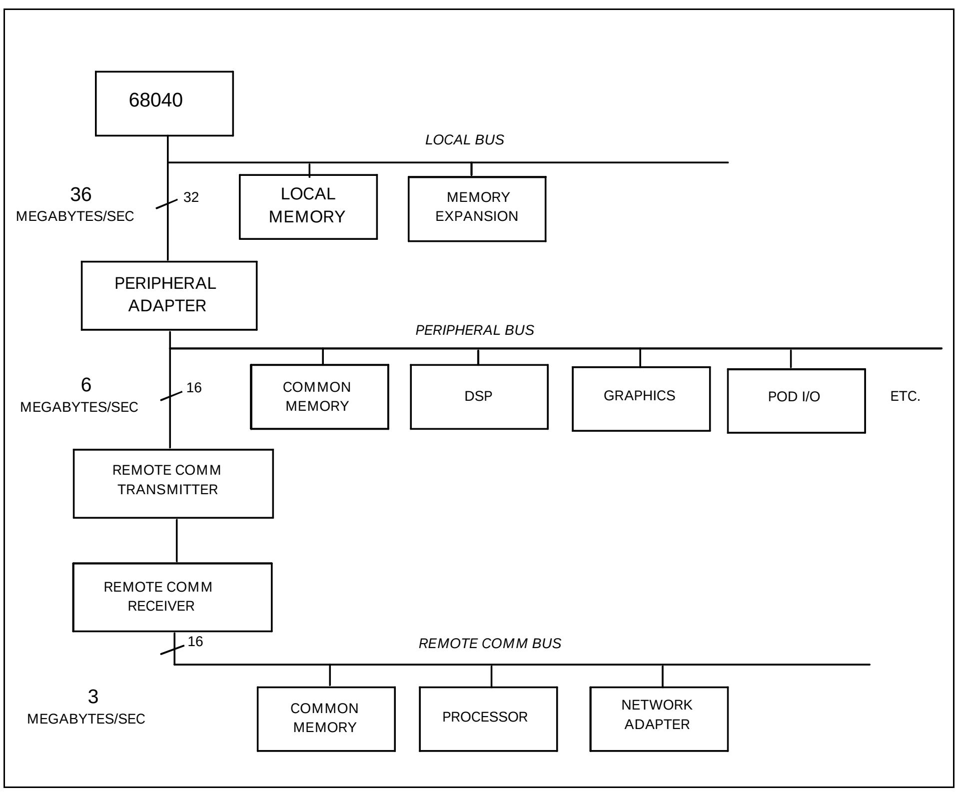

Fig. 2-1 SC9000 Bus Structure

2.1.1 Local Bus

The local bus is a 32 bit data bus connecting the 68040 to its main bank of 8 meg Flash and 8 meg DRAM memories. Both memories are optimized for multiple word transfers allowing efficient cache fills. This bus has an optional daughter card connector allowing expansion or overlay of the main memory space. This bus has a max bandwidth of 36 megabytes/sec.

2.1.2 Peripheral Bus

The peripheral bus is the main system bus connecting all the internal subsystems together. Both the local bus and the peripheral bus are confined to the processor board. The peripheral bus is a 16 bit data bus with several bus masters and a common memory. This memory is the main battery backed up SRAM for the monitor and contains 1 mbyte. The peripheral bus has an optional daughter card connector allowing expansion of the peripheral bus.

Bus masters include the following:

a) POD Comm

b) DSP

c) Host (68040)

d) Daughter card

The bus slaves include the following:

a) Graphics

b) Audio

c) UARTS

d) Recorder FIFO

e) Power Control

f) Memory Card Adapter

g) REMOTE COMM bus

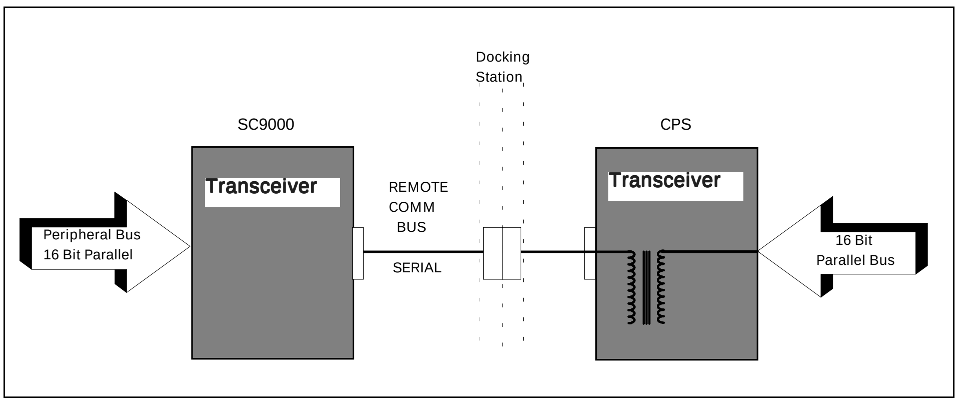

Fig. 2-2 REMOTE COMM Bus

2.1.3 REMOTE COMM Bus

The REMOTE COMM bus is a bus extender used to extend the main bus of the host external to the main unit. The parallel address and data bus are serialized using high speed FDDI transceivers allowing virtual parallel access to a remote parallel bus. This parallel bus is located in the CPS communication power supply module. Currently this bus interfaces to a network controller and other local serial buses. In the future this device may be housed in an expansion chassis allowing for other type of peripheral devices. These devices might include additional graphics adapters, analog output cards, additional MIB ports, etc. The host is stalled until completion of all read operations but is released after a write is latched to be serialized.

2.1.4 Error Handling

The SC9000 hardware provides several circuits for error detection, error recovery, and safety. The peripheral bus and REMOTE COMM bus both have timeouts implemented with the arbiter to prevent a lock up of the system. The REMOTE COMM bus also contains a CRC for serial transmission to and from the CPS. If a bad CRC is detected an interrupt is sent to the 68040. The main DRAM memory for the 68040 is protected with parity. If a parity error occurs an interrupt is sent to the 68040. The 68040 is protected with a watchdog timer. If the timer expires, the system initiates a reset and restarts the monitor.

The power conversion board monitors the main CPU and has an independent piezo alarm that can be sounded if the clock to the main CPU is broken. This piezo is also sounded if the unit turns off without going through a software shutdown. The power switch on the front panel is a request to software to shut down the monitor. If a shutdown sequence is initiated but for any reason fails to complete, a hardware override turns the unit off after a 10 second timeout.

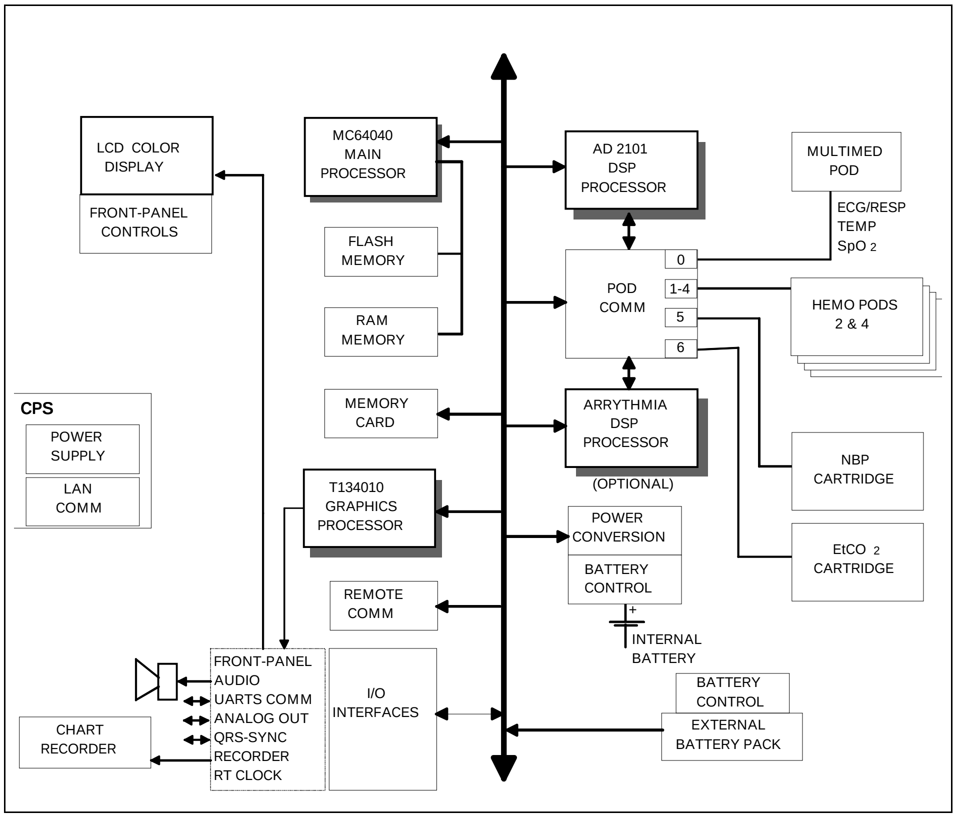

Fig. 2-3 SC9000 Block Diagram

2.2 Main Unit

The SC9000 is designed to be lightweight and portable. The division of the REMOTE COMM bus and peripheral bus are a direct mapping of what is needed during transport and what can be left in the patient’s room. The REMOTE COMM bus is connected and disconnected via a docking station which has a locating feature for the monitor as well as a locking latch. The main unit contains 4 circuit boards: the processor, the power converter, the frontend, and the front panel.

a) The processor board contains most of the circuitry for the monitor. It houses all of the computer functions as well as some patient isolation communication channels. The processor board uses downloadable FPGAs (field programmable gate arrays). The control logic for the processor board is comprised of 8 RAM-based FPGAs which are configured at power-up. The configuration of these FPGAs may be downloaded with the memory card, and is automatic with SW installation.

b) The power conversion board operates on a DC input from 11 to 15 volts. It switches between the external supply, the external battery and the internal battery for the proper power source and generates all the necessary dc voltages for the unit. It also charges and maintains the internal battery and external battery.

c) The front end board is a built in acquisition pod. It contains the parameters ECG, Respiration, Pulse Oximetry, and Temperature. The ECG system is a DC coupled system. The pacemaker detection and ESU filters are implemented in a DSP.

d) The front panel board is an interface board used to adapt a particular LCD panel to the processor board. It also interfaces the front panel rotary knob and keypad. The front panel board contains the backlight invertor with a PWM input to allow for brightness control in order to save power. It also has an alarm speaker with an attached microphone for failsafe feedback of the audio system. The front panel board is the only board that is embedded in the front frame with the LCD.

2.2.1 Cooling System

The cooling system for the main monitor is comprised of internal heatsinks cooled by forced air from fans. The two fans also provide direct air cooling of components not attached to the heatsink. The fans are speed controlled and are kept at low speed until elevated ambient temperatures are encountered, a blockage of air intake occurs, or a malfunction occurs. There are multiple temperature sensors in the monitor allowing for monitoring of the thermal performance. The hard-ware has built in overrides to force high speed of the fan in extreme heat and eventually turn the monitor off before damage to the LCD can occur.

Fan Control

Two fans cool the SC9000. They normally operate at low speed providing adequate cooling without excessive accumulation of dust and at very low audible noise levels. When the ambient temperature is above 95°F, a temperature sensor internal to SC9000 causes the fans to operate at medium speed. If a fault occurs in one of the fans, the other fan may operate at medium or full speed providing adequate cooling.

The SC9000 fans are controlled based upon two temperature sensor measurements. One sensor is mounted on the center of the processor board. The other sensor is mounted at the bottom of the processor board near the air inlet. Both sensors are connected to A/D channels for data acquisition. The sensor on the processor board is also connected to hardware that can override the software to cause the fans to operate at full speed when the temperature goes above 70°C. Additional hardware causes a unit shutdown when the temperature goes above 80°C.

Software has the ability to increase fan speed from low speed to medium or high.

Initialization

At boot up, the hardware sets the fans speed to high. Upon initialization of the temperature control algorithm, the first non-averaged temperature measurement determines the new fan speed setting.

User Messages

A message is displayed indicating that there is a cooling problem. When this message is presented, the user is directed by the operating manual to check for obstruction of the cooling vents, verify that the TAMB is not higher than 40°C and to check that both fans are operating.

If TPROC goes above 75°C, the software shuts down the power conversion board.

2.2.2 Real Time Clock

The Real Time Clock function is implemented with the EPSON-SEIKO RTC6413A device, and is synchronized by the Central Station.

2.2.3 Non-volatile Memory Battery Backup and Power Reset

The shared RAM and real time clock are provided with a lithium battery backup circuit to prevent corruption of this non-volatile memory during a power loss condition (both primary and battery power are lost). Note that the battery used for non-volatile memory backup should not be confused with the internal and external batteries that are used to provide power to the SC9000 base unit when primary power is lost. Non-volatile memory lithium battery backup is controlled by a power supervisory device that provides a power reset during a power loss condition.

NOTE: The battery is disconnected after manufacture. Upon power-up, the battery is automatically reconnected to non-volatile memory. No provisions have been made to recharge this non-volatile memory backup battery. Eventually (≈10 years), the battery must be replaced.

2.2.4 Quad UART

The QUAD UART provides four dedicated UART channels:

CHANNEL 1	MVP-1 UART RECEIVE/XMIT	SPEED SELECTABLE
CHANNEL 2	MVP-2 UART RECEIVE/XMIT	SPEED SELECTABLE
CHANNEL 3	BATTERY UART RECEIVE/XMIT	1200 BAUD (SELECTABLE)
CHANNEL 4	SC 9015 RECEIVE/TRANSMIT	SPEED SELECTABLE

2.2.5 CPS

The CPS (communication, power supply) has three boards -- the power supply, the network board, and the connector board. There are two versions of the network board.The first version is an SDLC communications controller allowing access to the SIRENET network. A second version allows for connection to the INFINITY network as well as MIB and CAN. The FPGA and main program memory on this board are downloadable by the SC9000. The power Supply is a medical grade universal supply operating from 88 to 264 volts ac.

2.2.6 HEMO POD

The HEMO POD is a hardware component placed on an IV pole near the patient, and is connected to pressure transducers and catheters. The POD measures invasive blood pressure, temperature, and thermal dilution cardiac output. The hardware contains a switched voltage source, instrumentation amps for press and temp, A/D conversion, and a communication ASIC. The POD also interfaces to a LCD display panel which is used to label the press transducers.

2.2.7 NBP

The NBP is a hardware component attached to the back of SC9000. The NBP hardware contains the front end acquisition circuits, pneumatic components and associated control circuitry. The NBP software algorithms are performed by the host computer.

2.2.8 Battery Pack

The battery pack contains a microcontroller that controls the battery charging and discharging processes. The controller also keeps track of the state of charge, and reports the status on an LCD. A history of the battery performance is used to provide an accurate indication of charge as well as to indicate to the user when the battery has reached its end of life.

2.3 Interfaces

2.3.1 Local Fixed Keys Interface

There are twelve fixed function keys on the SC9000 base unit, and a fixed key dedicated as a power on/off switch. The power on/off switch is unique in that it is not directly available via a peripheral bus status read command. The on/off switch is input to the power supply subsystem interface, where the switch state is detected and processed. Detection of a power off condition causes an interrupt to the host processor.

2.3.2 Local Rotary Knob Interface

The rotary knob is a 16 detent rotary knob. Each detent position indicates a "click" clockwise or counter-clockwise. The change in detent position is detected via a 2 bit quadrature code that changes value every time the rotary knob is moved into a detent position. Also included in the rotary knob is a push button switch that is operated by a press/release action. This switch is used to select menu items on the SC9000 screen.

2.3.3 SC 9015 Interface

The SC 9015 Interface is implemented in the QUART. QUART channel 4 has been dedicated as the communications channel between the remote monitor and the SC9000 base unit, and provides a full duplex transmit/receive channel from/to the remote monitor. This interface enables the fixed keys and rotary knob on the remote display to control the main unit, in parallel with controls on the main unit.

2.3.4 Fast Analog Output

The ANALOG OUT interface consists of two identical channels. Each ANALOG OUT channel provides a 12 bit D/A function. The design uses a dual DAC to produce the D/A conversion. The sampled analog data is then passed through a 2 pole low pass filter. The analog output has a maximum delay of 20ms, and can be used for a defibrillator or balloon pump.

Separate Pacer Spike generation circuits for analog outputs 1 and 2 are provided.

2.3.5 HiFi Audible Alarm Interface

The Audible alarm interface for SC9000 consists of an FM synthesis and Audio DAC chip set. There is also power amplifier drive circuitry for the 3 speaker interfaces: the internal speaker located in the base unit, the speaker located in the remote CRT monitor, and the headphones jack. Circuitry has been included to provide a mechanism for automatically generating an error tone when a watchdog failure occurs.

The chip is loaded with tone frequency, pitch, harmonics, and volume information by the host processor, which controls the duration of the tone. The audio DAC converts the received sampled tone data and produces a sampled analog representation of the tone data.

The local speaker interface (also designated as main speaker interface) is designed for an 8 ohm speaker load. This local speaker interface produces 1 watt of power into an 8 ohm load, and has thermal shutdown capability. An audio loopback interface for the main speaker has been provided. The audio loopback signal detects the signal amplitude produced by the speaker, rectifies and filters the signal, and inputs the filtered DC voltage value to the A/D MONITOR diagnostics DAC.

The remote speaker interface is designed to produce a 1Vrms maximum signal into a 1 kohm load, and provides an ac coupled output.

2.3.6 LED/Status Interface

Four LEDs provide for 16 LED/STATUS codes in the present SC9000 configuration. 12 are dedicated to the host processor. Four are dedicated to the Graphics processor (34010).

2.3.7 QRS Sync Out Interface

A QRS sync output is provided. The QRS SYNC OUTPUT is an open collector type output driver that is pulled up to +12 volts (active HIGH). The output is initialized to 12 volts on reset or power on.

This QRS signal is available via an external connector mounted on the SC9000 Front End PC board.

2.3.8 Local Alarm Out Interface

A Local Alarm output is provided. This Local Alarm Output is an open collector type output driver that is pulled up to +12 volts. The output is initialized to ground (0 volts) on reset or power on (active HIGH).

Loopback status is available via a peripheral bus read command.

The Local Alarm Out signal is available via an external connector mounted on the SC9000 Front End PC board.

2.3.9 Remote Alarm Out Interface

The Remote Alarm Output Interface is located in the CPS subsystem. This output is an open collector output with a +12V pullup resistor, fed from the monitor.

2.3.10Recorder Interface

The Recorder interface has been designed to connect to an external recorder via the base unit docking station connector. The recorder interface provides all of the necessary control, data and power supply signals required to drive an external recorder.

One pin for recorder power and one pin for recorder ground have been assigned to the docking station connector. The recorder power supply interface is similar to POD and cartridge inter- faces. The power control ASIC provides the recorder power supply enable control signal.

The recorder interface UART receiver has been implemented in the Peripheral Control ASIC. Thus, both the recorder transmit and receive uart communications channels are implemented in an ASIC.

2.3.11Backlight Control

The SC9000 display requires a fluorescent backlight for visibility. The backlight inverter is located on the front panel board. The intensity of this light is controlled by a variable power ac inverter, based upon ambient light detection and operator selection. A 10 KHZ signal is pulsewidth modulated to vary the voltage in 64 increments. A 10KHz 6 bit PWM is implemented on the processor board to provide this control and a filter on the front panel board converts this digital signal to an analog voltage for controlling the back light inverter. A separate signal from the SC9000 processor board shuts the inverter off to prolong the bulb life when display operation is not required.

2.3.12Serial EEPROMs

There are four accessible serial EEPROM devices, which contain the Memory Serial Number and Memory Constants. Two are located on the main board and two are mounted on the rear housing.

The two serial EEPROMS located on the main board contain certain non-volatile data, such as the SC9000 Main board revision, board ID, and other pertinent service/manufacturing information. The Memory Constants EEPROM contains various constants and other rarely modified values, such as log information, which are accessed during normal monitor operation.

The two serial EEPROMs mounted to the SC9000 base unit's chassis frame contain similar information. The two chassis EEPROMs interface with the main board via a 4 wire cable. The chassis Memory Serial Number EEPROM contains the SC9000 base unit's mechanical chassis and board revision, ID, and other pertinent service/manufacturing information, to be used for automatic SW compatibility check when SW is upgraded. The chassis Memory Constants EEPROM contains various constants and other rarely modified values associated with the unit and chassis, such as log information and LCD backlight hours, which are accessed during normal monitor operation.

The main board and chassis Memory Serial Number EEPROMs are read only I/O devices during normal operation. The data can be modified only if a jumper is shorted to enable write control to these serial EEPROM's. The chassis Memory

Serial Number EEPROM has been designed so that the data can be written only during manufacture. Thus, during manufacture, all required data is programmed into this EEPROM. After programing is complete, the write control is disabled and this chassis EEPROM becomes a permanent read-only device.

2.4 DSP Subsystem

The monitor utilizes several DSPs (digital signal processors) (see Fig. 2-3). The DSP is a specialized microprocessor that executes with high speed serialized operation. It is used to offload the main CPU from tedious repetitive number crunching. This keeps the main CPU free for effective control of variable computing. Since the execution code is downloaded into the DSP upon power-up the SW flexibility extends to the Hardware.

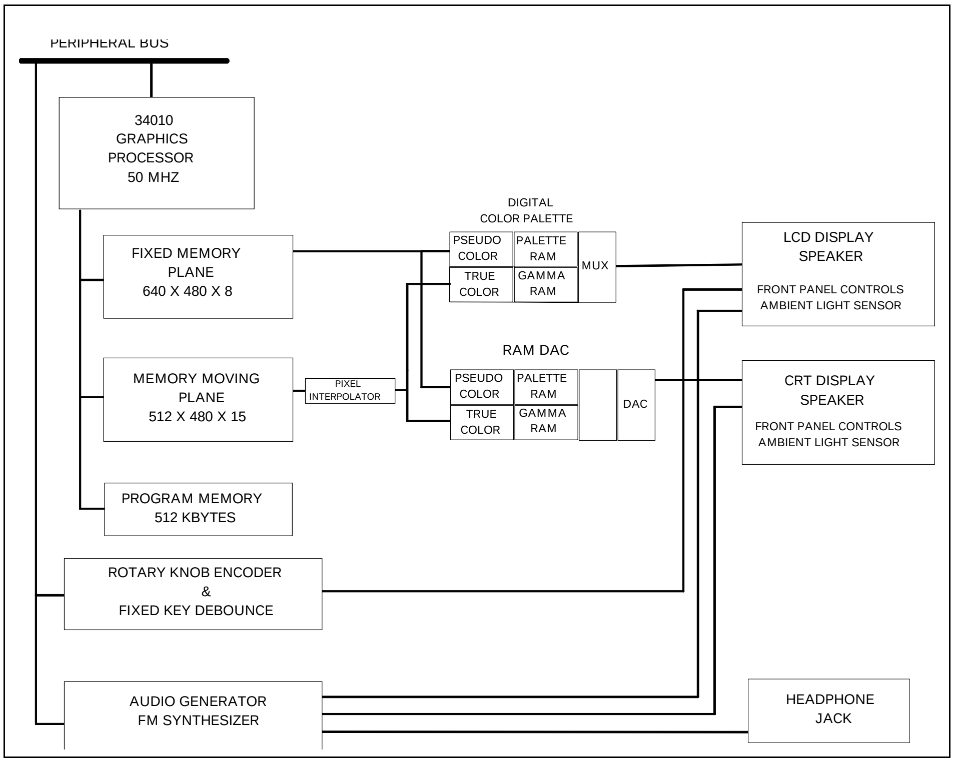

Fig. 2-4 Graphics and User I/O

2.5 Graphics Subsystem

2.5.1 Purpose and Scope

The SC9000 Graphics System Processor (GSP) is a subsystem of the SC9000 processor board which provides graphics capability for the SC9000 monitor (see Fig. 2-3, Fig. 2-4, and Fig. 2-5). Use of an independent Graphics Processor allows the Host processor to generate complex displays using a high level graphical interface, eliminating the need for the host to perform the required low level graphic library functions. Support in hardware is provided for display of moving waveforms and for the shading techniques required for smooth scrolling of waveforms at the required sweep speeds. The GSP supports simultaneous display of identical screens on a 640x480 color CRT and a 640x480 color TFTLCD (active matrix LCD).

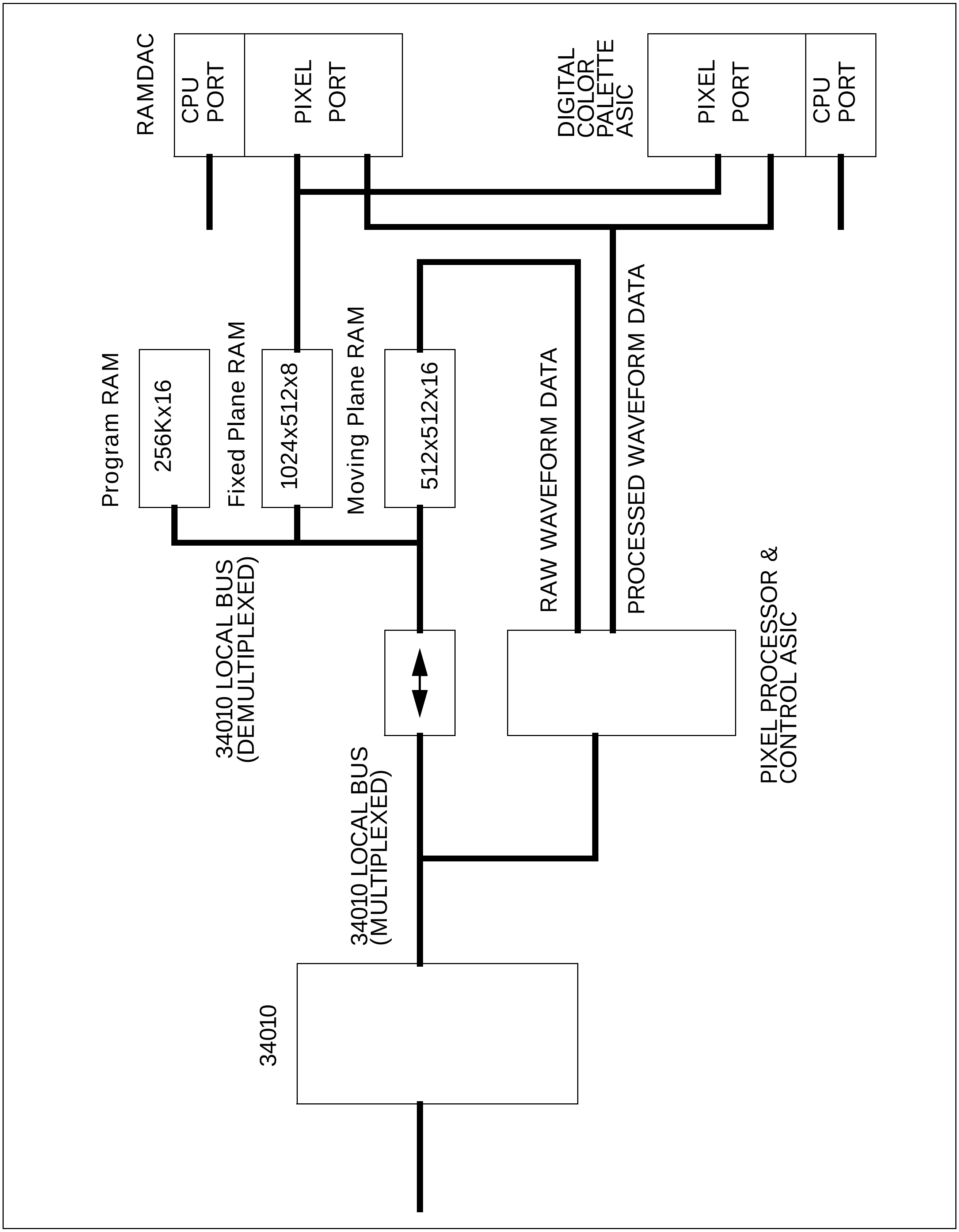

Fig. 2-5 Graphics Subsystem Block Diagram

2.5.2 Functional Description

The SC9000 GSP is designed around the Texas Instruments TMS34010 Graphics Processor, a 16 bit microprocessor specifically designed for graphics processing. It is capable of operation as either an independent processing unit or as a co-processor to a Main processor via the Host port. The SC9000 GSP operates in the latter mode. The 34010 provides the required control signals for, and in fact, assumes the use of Video RAM for the bitmap memory. The video data shifted out from the VRAM is subjected to additional processing in an ASIC (Application Specific Integrated Circuit) before being used to drive the RAMDAC and Digital Color Palette. The outputs of the RAMDAC and Digital Color Palette are used to drive a color VGA monitor and a color VGA active matrix LCD, respectively.

2.5.2.1 Fixed Plane

The Fixed Video Memory Plane contains fixed alphanumeric or grid data or any other type of data which must be displayed at a fixed screen location.

2.5.2.2 Moving Plane

The Moving Video Memory Plane contains waveform data that must be scrolled smoothly in a horizontal direction. The pixel width is 16 bits, but only 15 bits are actually used. The moving plane data is in True Color format, with 5 bits reserved for each of the primary colors, red, green and blue.

2.5.3 Display Update

In order to continuously update the contents of the display devices, the contents of the video bitmap memory is read from the memory and transmitted to the display(s) in synchronization with the video timing signals. The display subsystem supports two waveform drawing modes -- moving and erase bar.

2.5.3.1 Sub-Pixel Positioning

The waveform data is anti-aliased during the drawing algorithm to eliminate the "jaggies". However, additional processing is still required to allow the waveform data to be scrolled smoothly at the desired sweep speeds on a display of arbitrary dimensions and/or with a fixed number of pixels per line. The algorithm consists of a linear interpolation of adjacent pixels on a line, weighted by a sweep index factor.

2.5.4 Video Output

The fixed and scrolling data are combined and the appropriate data sent to the display devices. Fixed plane data normally has precedence over moving plane data.

2.5.5 Active Matrix LCD Display

The LCD display is a digital input device. At present, LCDs with three or four bits per primary color are available. This design can be expanded to a maximum of six bits per color as these panels become available.

The LCD must also display both fixed plane and scrolling plane waveform data. A color palette is provided in the Digital Color Palette ASIC, whose outputs are digital rather than the analog outputs required to drive a CRT display.

2.5.6 Mechanical Specifications

Connectors

CRT Video Output	Docking Station Connector
LCD Video Output:	30 pin 2 mm pitch dual row header

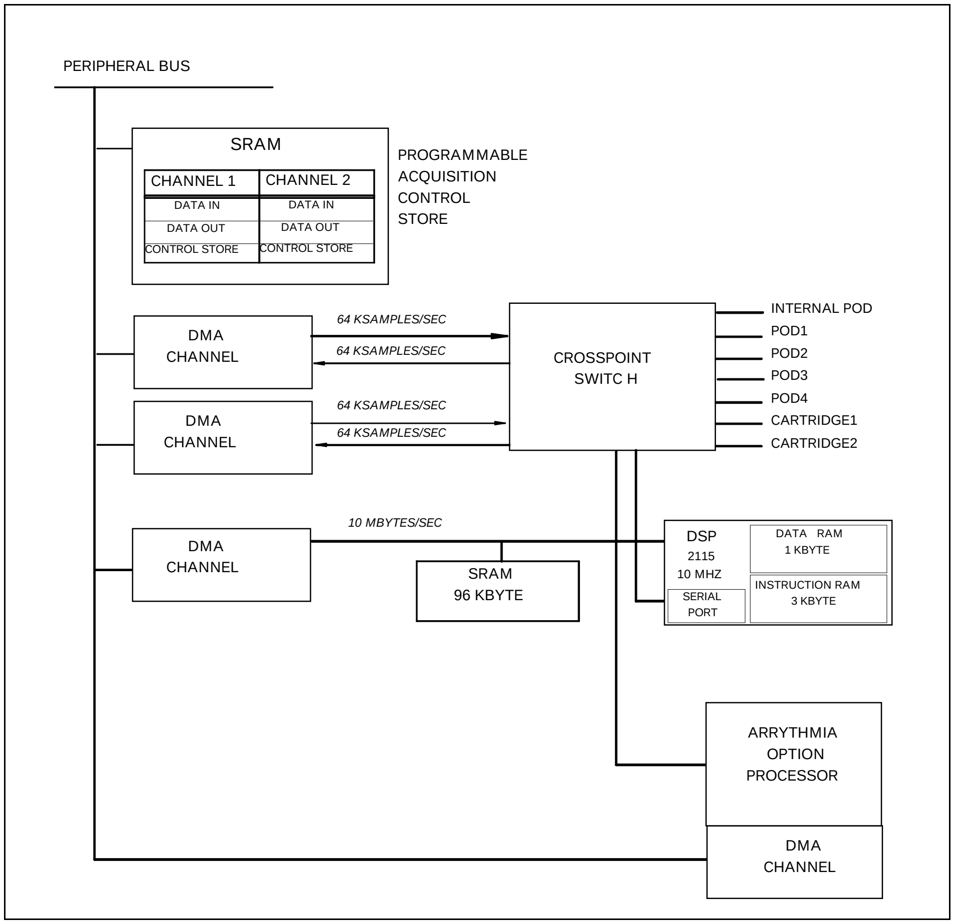

Fig. 2-6 POD Comm System Hardware

2.6 POD Comm System

2.6.1 Data Acquisition DMA Controller

Refer to Fig. 2-6. The data acquisition is controlled by a DMA Controller which operates on five circular buffers residing in the local SRAM memory. There are two channels, A and B, which are each allocated a transmit and receive buffer. The receive buffer stores the results for each time sample. Additionally, a control buffer is utilized to steer either channel to one of the five POD ports or the two cartridge ports. The channels provide all timing and control to communicate with the external pods and cartridges. Functionally the serial links to all seven devices are the same. Physically the POD ports 1-4 are individually patient isolated on the board; the MultiMed POD and cartridges are required to provide their own isolation.

2.7 Power Conversion Board Hardware

2.7.1 Power Control

2.7.1.1 Power Buss

All SC9000 monitor loads are powered from a DC power buss within the monitor called VBUSS, which powers the +3.3VDC, +5.0VDC, +12VDC, -12VDC, -15VDC and charger power converters located on the Power Conversion board. VBUSS is also routed to the Front End, Front Panel and the Processor boards, where it powers the pods, cartridges and backlight.

All power sources are connected to the Power Conversion board, and whichever source of DC power is appropriate for powering the SC9000 monitor is connected automatically to VBUSS via logic and power switches on that board.

2.7.1.2 Power Up

The user may power SC9000 on by actuating the ON/OFF switch. The switch is monitored by the power conversion board logic. At the time of power up, the +3.3V, +5V, +12V, -12V and -15V supplies to the SC9000 processor board are activated and logic circuits on the processor board sequence the power to the Pods, Cartridges and Recorder.

2.7.1.3 Power Down Initiation

The power down sequence may be initiated by the user or the battery processor. The user may initiate the power down sequence by activating the on/off switch.

Alternatively, the power down sequence may be initiated by the internal battery processor when the battery discharges below it's cutoff voltage.

When the power down sequence is initiated, the power conversion board control logic generates an interrupt for the SC9000 processor board. The processor board then performs all required power down routines and issues a command to the power conversion board to shut down the power. If the processor doesn't issue the shutdown command to the power conversion board within 10 seconds of the interrupt, the power conversion board shuts itself down.

An interrupt latch resides in a gate array on the processor board and is set by a pulse from the power conversion board logic.

During the power down sequence, a command to restart from the on/off switch is ignored.

2.7.2 Battery Charger

The battery charger has outputs to charge both the internal and external batteries. The control logic and the battery processors control the charger without intervention from the processor board. However, the processor board disables the charger when recordings are being made to limit the maximum overall SC9000 power draw.

The internal battery is charged first to insure that it is available for back-up. Once the internal battery is charged, the external battery is charged. A fully discharged internal battery is charged in 4 hours, and a fully discharged external battery is charged in 12 hours. At an ambient temperature of 35°C or higher, the charge times are increased.

A UART duplex from each battery transfers battery status and fault information to the processor board.

LED	CONDITION	LED STATE
POWER	PROCESSOR POWER ON	ON
	POWER OFF	OFF
CHARGER	DC POWER (CPS) CONNECTED	ON
	EXTERNAL DC POWER (CPS) OFF	OFF
	BATTERY OR CHARGER FAULT	OFF

Table 2-1 LED Indicators

2.7.3 Indicator LEDs:

There are 2 green LED indicators on the front panel of SC9000 to indicate the power and charger status (see Table 2-1). The LEDs are controlled by the power conversion board logic as indicated below:

The charger LED is off during battery fault because the charger is disabled under that condition.

2.7.4 Battery Power Selection:

While the SC9000 is operating at full load, power source transitions must occur without any operational disruption. These transitions include plugging in or unplugging the external battery while operating from internal battery and plugging in or unplugging the docking station or PSL connectors.

The control logic on the power conversion board selects the source for supplying power to SC9000. This is based upon the status bit information provided by the internal and external batteries as well as docking station power sense status. The power and battery status information is available to the processor board via two digital lines as follows:

MODE1	MODE0	STATE	INDICATION
0	0	0	operating on external power
0	1	1	operating on external battery
1	0	2	operating on int. batt. >10 min. left
1	1	3	operating on int. batt. <10 min. left

When operating in state 0 and the external battery pack is not fully charged, an 8 segment bar graph appears on the user display indicating the fraction of energy available from the external battery. In that state, there is also a message displayed indicating that the internal battery is low when the internal battery is less than 50% charged. If the internal battery is depleted, the message indicates that condition instead. When SC9000 is operating in state 1 the external battery bar graph is displayed regardless of it's state of charge.

When operating in states 2 and 3, the bar graph is replaced with a message instructing the user to replace the external battery pack. During state 3, there is also an audible alarm every 15 seconds.

2.7.5 Power Conversion Gate Array

The following control functions are provided by the gate array:

- Switching of power to the control circuits.
- Switching of the power source from the internal battery, external battery or docking station.
- Sequencing of the SC9000 processor board +5V and +3.3V supplies. Switching of the ±12V, -15V supply. Power down control including timed shutdown. Power supply overvoltage and over temp. protection.
- Control of the front panel LEDs
- Control of the battery charger and switching of its output to the internal battery or external battery.
- Status output to the processor board.
- Generation of clock signals.

2.7.5.1 Charger Control

The charger control switches the charger on when needed and directs the output to the appropriate battery. The internal battery has priority for charging. When both batteries are charged, the charger enters the trickle charge mode and time multiplexes the output at 25% duty cycle over a 64 second period. The PWM output to the charger is switched to the corresponding battery processor PWM output during the charging process.

2.7.6 Power Manager Subsystem Hardware

Power Control: PODs, Modules, Recorder & Memory Card

A management circuit controls the power for the external devices which connect to the SC9000 baseunit. Its primary function is to limit the current surges when the devices are powered on and to monitor for overloads.

Memory Card Power Control

At initialization, the Memory Card power (+5 v and +12 v) is normally disabled. However, if the MC Boot signal is active, the power will be enabled so that the processor can boot from the memory card. The power will be cycled if a power fault is detected or the card is disconnected.

The +12 volts is generated from the Flash programming voltage. Therefore, that voltage is turned on first. Overcurrent protection is provided on the programming voltage.

Battery Back-up Connection

A register controls the activation of the battery backup feature. At powerup, the backup feature is automaticly activated. If the units is put in long term storage, the battery can be electronically disconnected in order to extend battery life.

2.7.7 Piezo Alarm:

The piezo alarm is activated for various time durations, based upon the cause as follows:

Cause	Duration
User Turn On	2 Seconds
User Turn Off	2 Seconds
Int Batt Turn Off	>10 Seconds
Fault Turn Off	>10 Seconds
Processor Watchdog	Continuous
Speaker failure	Continuous
+5V Undervoltage	>10 Seconds
+3.3V Undervoltage	>10 Seconds

2.7.8 Electrical Specifications

These specifications indicate the design limits of the power system, and as the SC9000 product line matures may not necessarily relate to the design configuration of a specific SC9000.

2.7.8.1 General

All power supplies that go off the board are protected against damage resulting from a short to ground for an indefinite time. They also have overvoltage protection to prevent them from sourcing excessive voltage. VBUSS is protected from overload by fuses located on the power conversion board and in the internal battery pack.

2.7.8.2 Power Supply Input

CPS, PSL Source (Meas.at SC9000 connectors):11.0 to 15 Volts DC @ 8.3 A_{max}.

External Batt. Source: 10 Ni-Cd cell pack, 10 to 15 VDC @ 9.1 A_{max}.

NOTE: All loads and converters function to a minimum voltage of 9.4 volts. They also continue to function through a VBUSS dip of 0.4 volts for 25usec.

PSL, Docking Station Input Voltage Protection: -24 to +24VDC.

2.7.9 VBUSS Loads external to the Power Conversion board (max.)

Fans 2.2W

Recorder19.0W

Cartridges, Pods30.0W

Backlight11.8W

Total63.0W

2.7.10Electrical Specifications

Unless otherwise specified, VBUSS range= 9.4 to 15 VDC. During power transfer, VBUSS may dip as much as 0.4 VDC for 25 usec.

PODs (4): Isolation= 3 KVRMS, 5.6 KVDC (5 sec.)

2.7.11 Front End Board Power Control Functions

Module Power:

The front end board contains the current limit and overload detection circuits used for Module power. The control of these circuits is performed by gate arrays on the processor board.

Isolated Front End Power Supply:

The power for the isolated front end is provided with a similar circuit to the POD power. The DC output from the isolation supply feeds a DC to DC power supply that provides the regulated output voltages for the ECG, SpO2 and temp. circuits.

2.8 Front Panel Interface Hardware

2.8.1 Introduction

The SC9000 Front Panel Interface provides an interface to the various operator related functions. The interface consists of circuitry and connectors that allow the SC9000 main board processor to access all of the operator related functions.

2.8.2 Functional Description

The Front Panel Interface Board provides an interface between the SC9000 main PC board and the operator related functions. Both the Front Panel board and the main board are contained in the SC9000 monitor base unit. The Front panel board mates to the SC9000 main board via two 30 pin connectors. Ribbon cable is used to interconnect the two boards. The two 30 pin connectors provide the main board with all of the required user I/O control and feedback signals associated with the front panel board.

The Front Panel interface provides connectors and circuitry needed for the following functions:

- LCD display
- LCD temperature sensor
- LCD Backlight Inverter
- ambient light sensor
- base unit local speaker and audio feedback
- base unit local rotary knob and keypad interface
- battery and power LED's.

All of these operator related functions have been integrated with the corresponding circuitry on the SC9000 main board.

2.8.3 LCD Display Driver/power Interface

The front panel board provides a pass through for all of the LCD Driver signals that originate on the main board and are input to the LCD Display. All of the driver signals are input to the front panel board via one of the 30 pin connectors, and passed through to the LCD Display via the LCD Display 30 pin ZIF connector mounted on the front panel board. The graphics subsystem located on the main board generates all of the LCD driver signals.

2.8.4 LCD Backlight Inverter Interface

The Backlight inverter circuitry for the LCD backlight is resident on the front panel board. The backlight inverter converts the VBUSS power supply input from the main board to the high voltage ac power inverter used by the backlight for the LCD Display. Note that the VBUSS power originates from the base unit power supply board, and the main board provides a pass through for VBUSS power from the power supply board to the front panel board. 3 pins on one of the front panel's 30 pin connectors have been dedicated to VBUSS. Another 3 pins have also been dedicated for PGND.

2.8.5 Audible Alarm Interface

The base unit's speaker is mounted on the front panel board, and connects to a two pin header on the board. The audio signal to drive the speaker is generated by circuitry on the main board. The main board provides the audio output signal and the audio return signal.

The front panel board provides an electret microphone and associated circuitry to drive the microphone. The microphone is used for audio loopback. The microphone is mounted in the speaker enclosure on the front panel board.

2.8.6 Ambient Light Interface

The base unit's ambient light sensor is mounted on the front panel board. The ambient light sensor is a photocell that exhibits a logarithmic change in resistance vs. light intensity. The ambient light sensor is connected in series to a 2kΩ potentiometer which must be used to calibrate the ambient light sensor. The two ends of the pot/sensor series circuit are output to the main board.

2.8.7 Local Rotary Knob/fixed Keys Interface

There are twelve fixed keys on the SC9000 base unit. Additionally, another key is dedicated as the power on/standby switch. The rotary knob interface provides a 2 bit encoder output and also a rotary knob push button signal output. All of the key/rotary knob signals are filtered. Schmitt triggers are utilized on the rotary knob 2 bit encoder output for extra noise immunity. All of the keypad switches have pullups except the power on/standby switch. Thus, the power switch signal output from the Front Panel board is pulled up by the power switch interface located on the power supply board.

2.8.8 Battery/power LED Interface

The battery and power LED's are turned on or off via the associated LED control signal from the main board. Both the battery and power led's are green when turned on.

The power and battery LED's have been integrated into the membrane switch interface used for the fixed key and power on/standby switch. The LED on/off control signals are provided by the base unit's power supply board. Thus, the LED control signals originate on the power supply board, pass through the main board to the front panel board, and then pass through the front panel board to the membrane switch interface.

2.9 Front End Board Hardware

2.9.1 Introduction

The SC9000 Front End board (POD-0) takes analog ECG, respiration, temperature, and saturated oxygen data gathered by the MultiMed POD from transducers at the patient and converts them to digital form for transmission through isolators to the Main Processor. Refer to Fig. 2-7.

Hardware has been designed to be used as flexibly as possible to enable software complexity to define the overall behavior. Bulky filters have been replaced by software filters. High resolution A/D converters replace ac-coupled stages and their autoblocs. Careful shielding and ferrite filters protect against very high frequency interference upsetting critical logic. Power has been reduced to facilitate battery operation.

2.9.2 Safety

- Patient isolation withstands 5kV.
- Leakage currents are limited to safe values normally and during single-component faults.
- Patient is protected against electrosurgical burns at the electrodes.
- Defibrillation protection does not drain excessive current away from the patient.
- Shields of specially shielded connectors for deflecting 1000MHz cannot be touched by patient even when disconnected.

- Single cable from MultiMed POD to main SC9000 unit reduces cable clutter between bed and monitor.

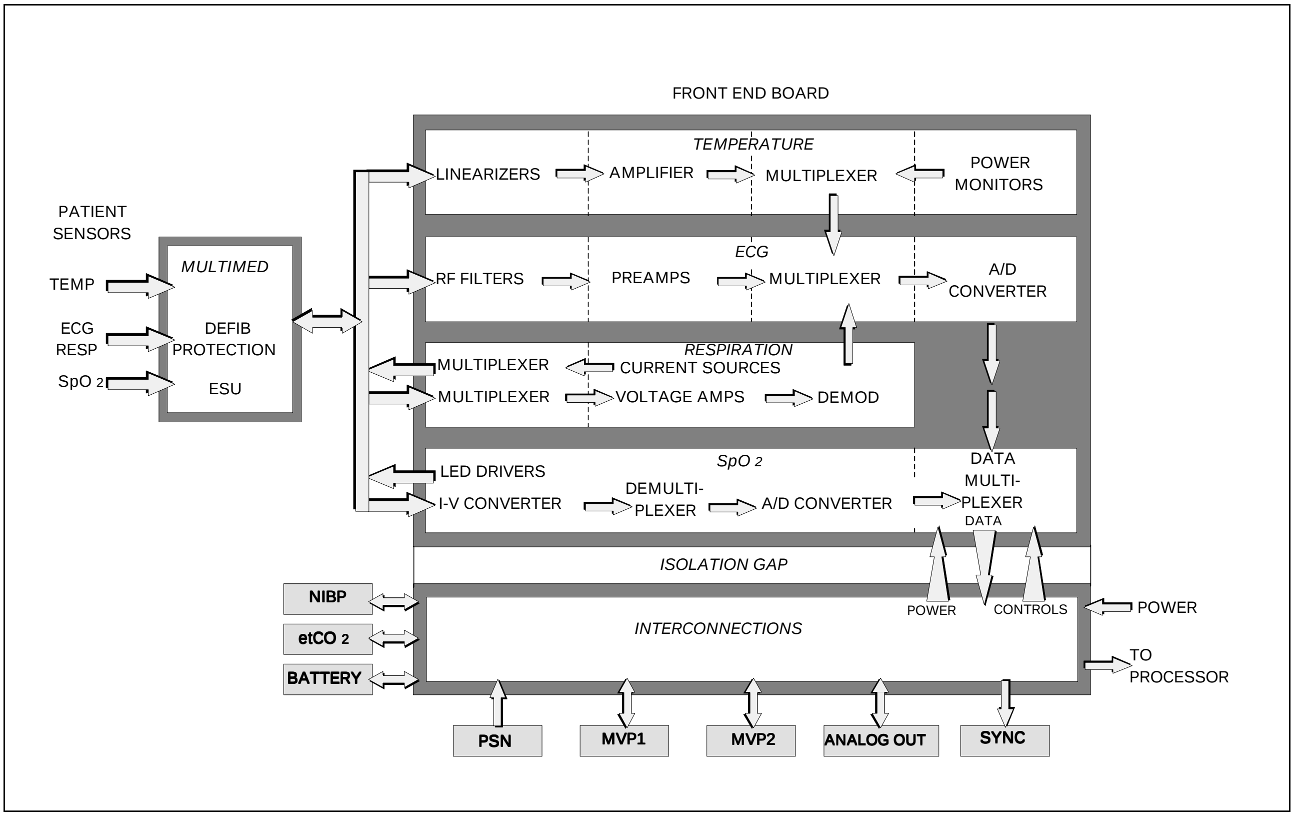

Fig. 2-7 Front End Board Hardware

2.9.3 Functional Descripton

Transducers gather physiological data at the patient and feed them into the small MultiMed POD at the bed. The MultiMed POD in turn is connected via a 3-meter cable to the Front End board in the SC9000 main unit where analog ECG, Respiration, Temperature, and SPO2 signals are converted to digital form and sent through isolators for processing. A small EEPROM memory stores serial and revision numbers.

ECG/Resp/Temp

The MultiMed POD located close to the patient accepts a set of 3 or 5 shielded ECG electrode leads, an SPO2 (Nellcor) cable adapter, and a temperature sensor. The ECG section contains RF filters, and overvoltage clamps that include 1k series resistors to limit shunting of defibrillator current. The SPO2 and temperature sections also contain RF filters. Impedance respiration is sensed through the ECG electodes. Void-free potting and internal shielding enable compact containment of high voltage defibrillator and electrosurgery pulses. The small interconnecting cable to the main SC9000 assembly is captive at the MultiMed POD but plugs into the Front End board via a specially shielded connector.

The Front End board accepts physiological signals from the MultiMed POD connector and feeds temperature, respiration, and ECG signals via RF filters, configuration multiplexers, and pre-amplifiers to a high-speed multiplexer and differential amplifier driving a 16-bit analog-to-digital (A/D) converter. SPO2 signals are fed to their own amplifiers and A/D converters, combined with the ECG data stream, and sent in to the SC9000 Main Processor board via an isolating tranformer link. Power, control commands, and clock signals from the Processor are sent out to the Front End board on similar inductively isolating links.

The ECG signals are conductively coupled to the isolated circuits via current-limiting series resistors, whereas the SPO2 signals are optically isolated at the transducer. Temperature signals are doubly insulated at the patient by disposable boots on the sensors. Ac (40kHz) excitation currents for respiration monotoring are dc-isolated by high-voltage ceramic capacitors.

ECG

Refer to Fig. 2-8.

- ECG is dc-coupled to facilitate ST-depression analysis.
- Pacer pulses may be detectable by software on any lead-pair.
- Bandwidth is set flexibly by software filters.
- Reconfigurable neutral selector can drive any electrode.
- Lead-on detection functions with even poor electrodes.
- Calibration voltages can be superimposed on patient wave-forms or onto flat baselines.

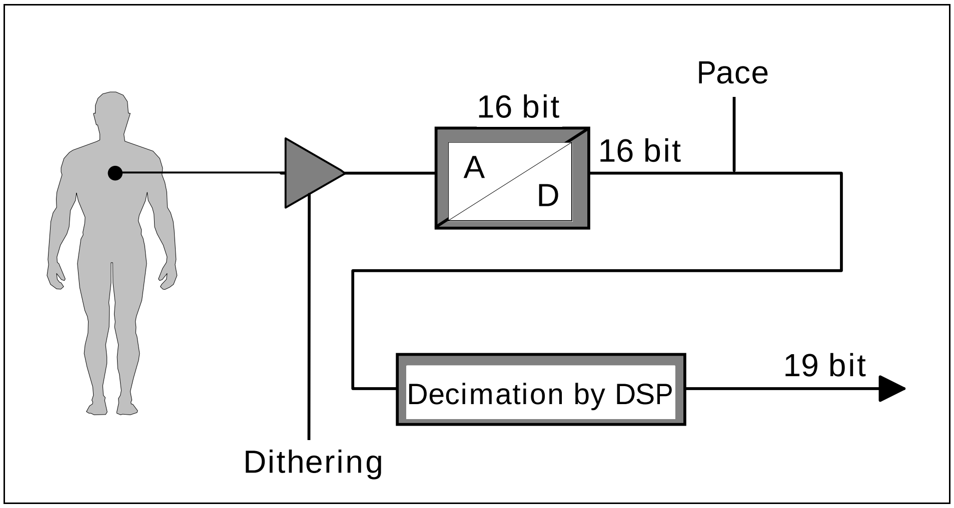

Fig. 2-8 ECG Functional Block Diagram

Refer to Fig. 2-8 and Fig. 2-9. Composite electrocardiographic (ECG) signals generated by the heart and by a pacemaker are filtered to reduce RF interference from impedance respiration and electrosurgery and then injected with dc lead-off detection currents. Over-voltage clamps protect the semiconductors from the surges passing the sparkgaps in the MultiMed POD and also reduce the dc current applied to the patient due to a component fault.

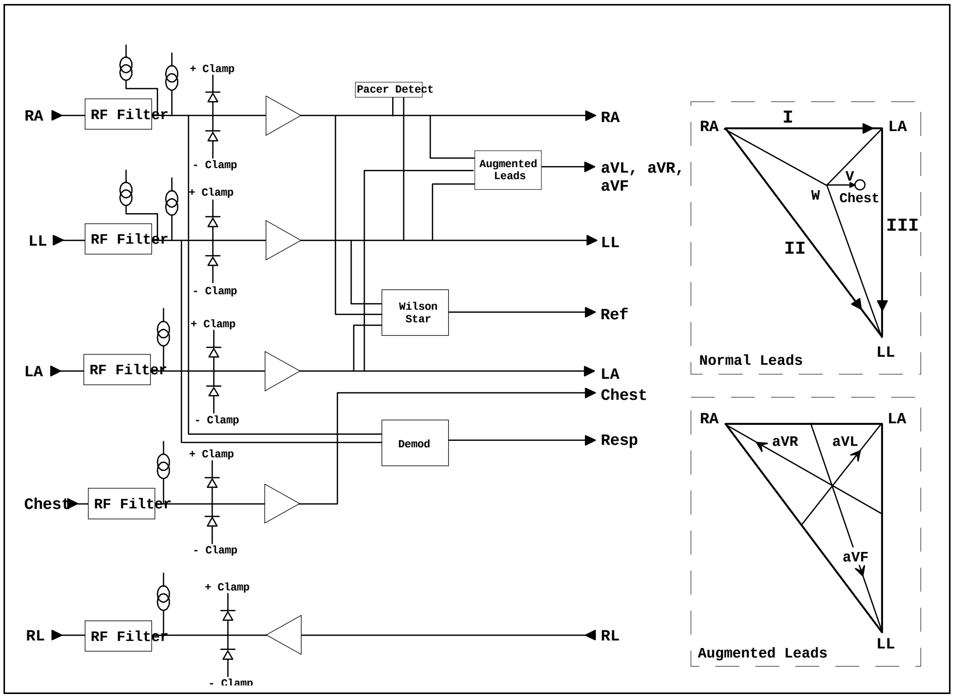

Fig. 2-9 Lead Forming Network

Grounding switches can disconnect the patient and ground the inputs to the preamplifiers to produce a quiet baseline for evaluating superimposed calibration levels (1mV re patient). The dc preamplifiers provide a high input impedance and double the electrode voltages to reduce the noise contributions from later stages. Calibration voltages can be injected into the common side of the preamplifiers without disturbing the electrode potentials at the patient. These relatively wide-band dc-coupled signals are presented to the A/D multiplexers for conversion. However, during electrosurgery, lower frequency interference due to rectification at the knife arc aliases and can corrupt the A/D samples. Hence an alternate path from the output of each preamplifier is provided via a 2-pole low-pass filter to other inputs of the A/D multiplexer.

The Wilson point, "W", the average of the LA, RA, and LL electrode potentials, serves as the negative reference potential for the V and V' lead-pairs and is also used as a measure of the common-mode potential of the patient (see Fig. 2-9). By driving the isolated common of the FRONT END board at the same potential as the Wilson point, the common-mode voltage across the electrodes is reduced nearly to zero and the effective common-mode rejection is improved. As most of the common-mode current is now forced through the neutral electrode, it becomes noisier and hence is not used as part of another signal path. Switches are provided to select other electrodes to be neutral if the RL electrode is off or missing. If the V' electrode is present, then it can be selected to be neutral so that the three Einthoven and the V lead pairs can still be used. However, the V' lead-pair will be corrupted due to neutral current noise. Similarly the V electrode can be selected to be neutral. Now that the RL is disconnected from the neutral driver, its potential can be monitored to determine whether it has been reconnected to the patient and thus is able to be reselected to be neutral.

If only the three Einthoven (LA, RA, and LL) electrodes are connected, one is selected as neutral leaving the remaining two electrodes to form one valid lead-pair. The "W" now contains the neutral drive signal which bypasses the neutral electrode and reduces the gain of the neutral driver amplifier. To improve the resulting poor common-mode rejection, a Wilson Grounding "WG" switch is activated to selectively disable the offending input to the "W".

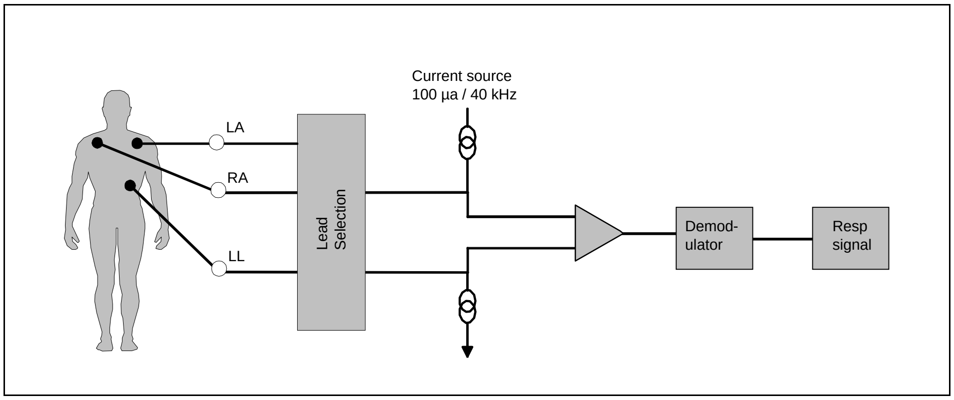

Fig. 2-10 Respiration Functional Block Diagram

Respiration

Refer to Fig. 2-10.

- Respiration is both ac- and dc-coupled in hardware, but only ac coupling at higher resolution is supported by software. DC is used for high Z sensing; ac is used for signal acquisition.
- Respiration may be monitored on any Einthoven lead-pair.
- Sensing uses active current sources which do not distort QRS.
- Detection sensitivity has low dependence on base resistance or electrode unbalance.

Impedance respiration is monitored by injecting a nominally 40kHz square wave of current into one ECG electrode and removing it at another ECG electrode. The resulting 40kHz voltage drop across those electrodes is proportional to the impedance. Specially balanced true current sources do not load the ECG electrodes or distort the ECG morphology. The waveform of the current is preemphasized to reduce the bypassing effects of cable capacitance. The returning 40kHz differential voltage is amplified, synchronously demodulated, and low-pass filtered. The resulting dc-coupled waveform is converted to single-ended form, optionally injected with an equivalent 1 Ohm calibration step, further low-pass filtered, and passed to the A/D multiplexer. An auxilliary ac-coupled stage with an "autobloc" dc-restorer feeding a separate input to the A/D multiplexer enables higher resolution capability.

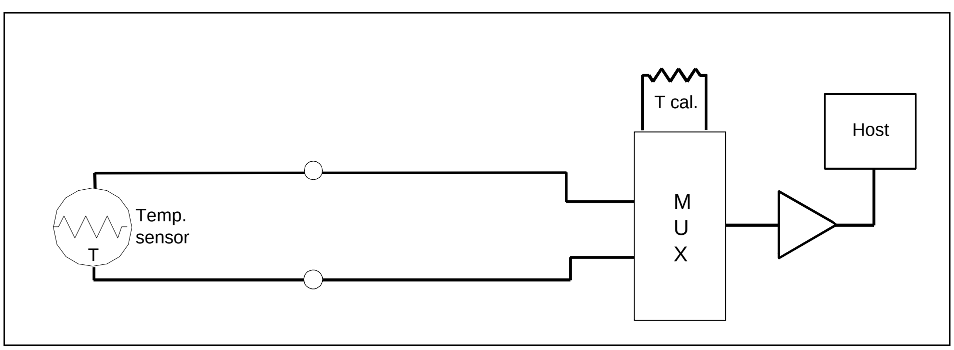

Fig. 2-11 Temperature Functional Block Diagram

Temperature

Refer to Fig. 2-11.

- Designed to meet the stringent German PTB requirements including detection of marginal accuracy due to degradation of a single component.
- A second temperature channel is reserved in hardware.

Temperature is sensed at the patient by a non-linear negative-temperature-coefficient thermistor. This is linearized with a precision resistor network and excited by the same reference as the A/D converter to a produce ratiometric digital output. An input multiplexer (MUX) selects among the external signal and internal reference dividers simulating -5 and +50°C. The dc amplifier matches the dynamic range of the A/D by combining, amplifying, and precisely offsetting the small signal from the multiplexer. Power supplies whose failure would invalidate temperature measurements are also monitored and compared against the A/D reference. The A/D reference is compared to the independent SpO_2 reference.

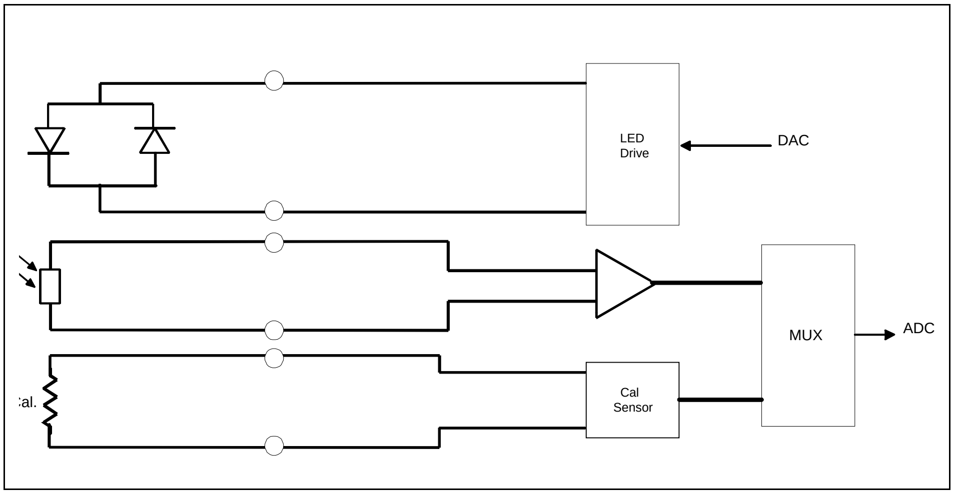

Fig. 2-12 SpO_2 Functional Block Diagram

SpO_2

Determination of the concentration of oxygen in the blood depends on the principle that the scattering of red (R) light depends on the degree of oxygenation of the blood, whereas the scattering of infrared (IR) radiation is independent of oxygenation and causes only constant attenuation. In the SpO_2 sensor, R and IR emitting leds are alternately pulsed on at a 25% duty cycle. The intensity of light (including ambient) transmitted through or scattered by the blood is converted to a current by a photodiode in the sensor. The current that appears when both leds are off depends mainly on the ambient light. This ambient contribution is later subtracted to leave only the R or IR signal levels. The large dynamic range of the light intensities requires constant automatic monitoring and adjustment.

The intensities of the R and IR sources are independently controlled by two digital-analog converters attenuating the 2.5V reference.

Attenuated radiation falling on the photodiode in the sensor is converted to a current which passes through an RF filter balun in the HVPOD and enters the overvoltage-protected current-to-voltage converter on the ECG POD-0 board. The resulting unipolar stream of pulses is offset to double the dynamic range and is then ac-coupled to a controllable-gain amplifier. As the gain DAC is in the feedback loop, the gain is inversely proportional to the digital control word.

A zeroing switch can ground the input to the controllable-gain amplifier to determine the amplifier offset. An alternate analog loopback test input to the controllable-gain amplifier can be switched in independently of the external sensor to inject level-shifted pulses proportional to the led drives. A comparator detects whether the current-voltage amplifier is saturated.

The calibration of each sensor is coded into the value of a precision resistor built into the sensor. The presence of this resistor is sensed by forming a voltage divider monitored by a comparator (UNPLGL). The value of the resistor ratio may be read by switching the input of the RED A/D to the output of the divider using the CALR mux.

A/D Conversion

The outputs of the A/D multiplexers supply the non-inverting and inverting inputs of a fast-settling differential amplifier having a gain of 2x. Fast-recovery overvoltage clamps prevent damage to the A/D, yet allow linear operation over the full range of the A/D. To improve the differential linearity, an analog dithering signal is added to the differential amplifier and later subtracted out of the resulting digital output from the A/D. The resulting noise is reduced by digital filtering.To extend the dynamic range of the A/D, oversampling of the ECG and Respiration signals are followed by digital filtering and decimation.

To evaluate the level of signals which may be outside the linear range of the A/D, an alternate single-ended input to the A/D from the non-inverting multiplexer is buffered without amplification and thus doubles the range of the A/D. This capability is needed to evaluate electrode lead-off or lead-on conditions, large respiration base resistances, and out-of-range temperatures. Dithering is not available for this wider but cruder range. Multiplexer inputs may be grounded for evaluating offsets of either amplifier.

Communications

The multiplexers, A/D, and EEPROM are controlled by the SC9000 Main Processor via a Manchester-encoded serial communications channel inductively coupled to the isolated Front End board. Most of the digital logic is contained in the "ECG" and "SpO_2" ASICs. Outputs from the A/D are Manchester-encoded in the "ECG" ASIC and fed to the "SpO_2" ASIC for combining into the inductively coupled data flow to the Main Processor. Information such as identification codes, serial numbers, and revision numbers are stored as read-only data. ID codes are burned into the ASICs.

A power-on monitor resets the ASICS until both ±5V have risen to normal range. The isolated dc-dc converters are self-starting when the raw isolated dc power via 890 kHz drivers is permitted to arrive from the Main Processor. The A/D converters are automatically calibrated after the power-on reset is cleared, but may be recalibrated later under software control.

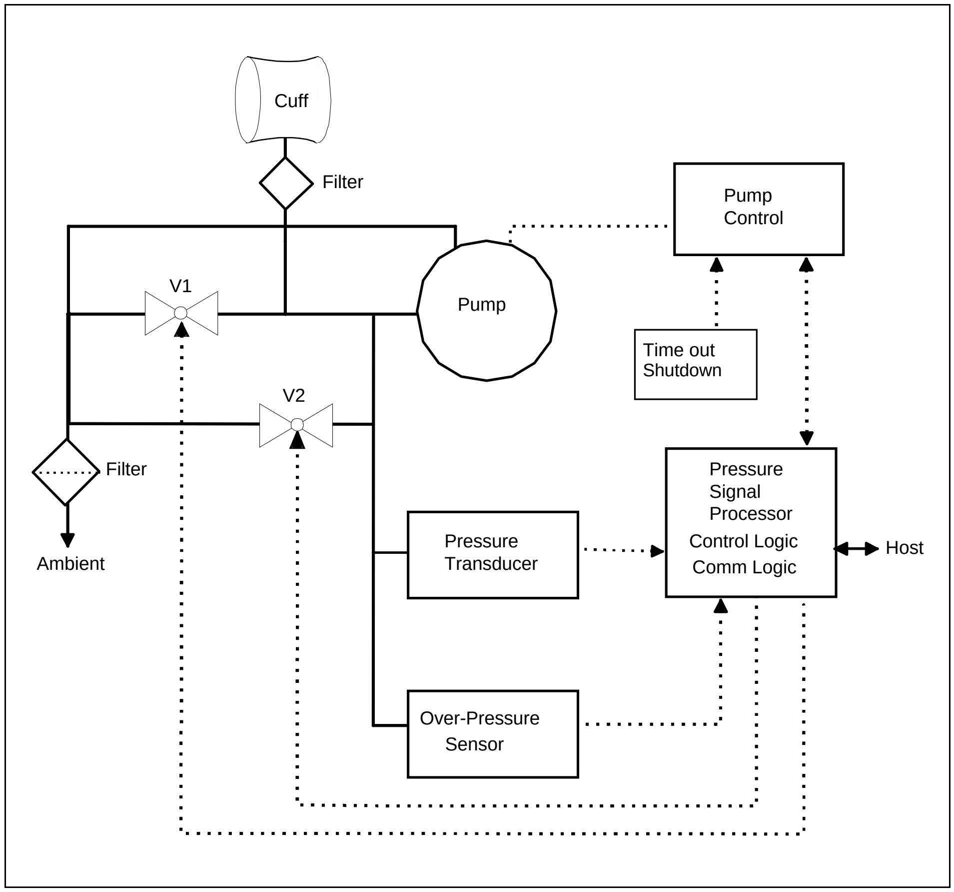

Fig. 2-13 NBP Functional Block Diagram

2.10 NBP Module

2.10.1 Introduction

The SC9000 NBP cartridge design measures blood pressure non-invasively using an inflatable cuff and the oscillometric method. The NBP algorithms are performed in the SC9000 68040 microprocessor.

2.10.2 Pneumatic Subassembly

The pneumatic subassembly consists of two modulating solenoid valves (V1, V2), a pump (P1), a filter, and a manifold. The manifold provides the interconnection of the air passages between the individual components and provides for their mechanical mounting. It also provides an acoustic attenuation of the valve and pump noise. The filters prevent contamination from entering the pneumatic system from the cuff hose or ambient air.

P1 provides the pressurized air to inflate the blood pressure cuff. V1 and V2 are used to control the air flow during the de-flation phase of a blood pressure measurement. V1 is a normally closed exhaust valve with a relatively small orifice. V2 is a normally open exhaust valve with a comparatively large orifice.

When a blood pressure measurement is initiated V2 is closed, P1 is turned on and the rising cuff pressure is monitored via pressure transducers. When the pressure has reached the target inflation pressure, P1 is turned off and a dynamic braking circuit brings the pump rapidly to a halt. Neonate inflation cycles are identical except that a speed control circuit is used to reduce the pump output to approximately 15% of the adult mode. The software monitors the slope of the pressure curve during inflation to estimate the cuff volume. This factor is used in the deflation process.

After the inflation, there is a short delay after the pump stops to allow thermal transients to settle. Either V1 or V2 is now modulated to control the deflation rate. The choice of V1 or V2 and the initial pulse width is made based on the estimated cuff volume determined during the inflation cycle. The chosen valve is modulated at a 20 Hz rate and the pulse width (open time) is continuously adjusted to provide a constant deflation rate. If initial deflation was started with V1 the software may determine that it needs to switch to V2 to maintain proper deflation. In any case when the measurement cycle is complete, V2 is opened fully (de-energized) to allow for rapid deflation.

A PC board assembly in the cartridge contains all of the control electronics for the cartridge as well as for the two pressure transducers.

2.10.3 Transducers

The measurement pressure transducer is D.C. coupled to a 16 bit A/D converter so that cuff pressure is measured with adequate resolution to detect blood pressure pulses. This eliminates the need for a separate A.C. coupled measurement channel with it's associated distortion and long transient recovery.

The overpressure transducer has two threshold settings. The adult setting is for 300 +/- 30 mmHg and the nominal neonatal setting is for 170 +/- 20 mmHg.

Both transducers share a common manifold and are mounted on the PC board.

2.10.4 Pneumatic Controls

The P1 control provides 3 functions. It limits the current to the pump when the pump starts to prevent power supply overload. It rapidly decelerates the pump when the pump is shut off by applying a low resistance across the motor. And it provides a closed loop speed control for low speed neonatal operation.

A relatively high pulse voltage is used to drive V1 and V2 to get quick response. This pulse lasts for approximately 2 milliseconds after which time the valve voltage is lowered to a holding value. At the end of the valve "on" time period, the valve voltage is allowed to reverse and the energy stored in the solenoid inductance is rapidly released into a relatively high voltage clamp circuit.

P1 and V2 are supplied by a redundant power switch so that, under fault conditions, they can be de-energized.

2.10.5 Safety timer

The software limits the measurement time to 119 seconds for adult mode, 89 seconds for neonatal mode and 59 seconds for French neonatal mode. A safety timer circuit monitors the current in P1 and V2, and if due to some failure (hardware or software), P1 or V2 remain activated for more than 120 +/- 1 seconds in adult mode, 90 +/- 1 seconds for neonatal mode or 60 +/- seconds in French neonatal mode, the circuit latches on, causing the redundant power switch to P1 and V2 to switch off. When the safety timer latch has been set, V1 is opened as an additional safety feature. Only recycling the cartridge power resets the safety timer latch. The safety timer circuit is functionally independent of the logic gate array.

When the cartridge is powered up, the safety timer is de-activated until the pump is started the first time. This feature allows service calibration without triggering the safety timer. Once the pump has been activated the timer circuit becomes functional.

2.10.6 Logic gate array

A CMOS gate array provides the control functions for the pneumatics and the communications with the SC9000 68040 microprocessor. These functions are listed below:

- 12 bit 20 Hz PWM and pulse control for V1 and V2
- Pump control
- POD communications interface

- Neonatal mode switching of pump and overpressure
- Safety logic
- Start/Stop Key Interface
- A/D data interface
- EEPROM Interface
- Clock Generation

Because the algorithms are performed external to the NBP cartridge (in the SC9000 monitor), a communications hand shake is necessary for the POD comm. to promote the safe deflation of the cuff should a hardware or software fault occur in SC9000 NBP control function.

2.10.7Watchdog

The NBP gate array has a 5 bit counter whose output is sent as data and incremented every 300 milliseconds. This data is echoed back to the gate array at the next watchdog data request, by the high level NBP algorithm software. The gate array compares the received data with the last transmitted data and, if it doesn't match, a fault mode is entered which causes the valves to open and the pump to shut off.

2.10.8Non-volatile memory

A EEPROM residing on the PC Board and stores pneumatic component flow factors. During calibration of the module at production system test and in the field, a 0.5 liter canister is connected to the cartridge. The cartridge automatically measures the pump and valve flow rates and determines their flow factors for the use in the flow control algorithm.

2.10.9Power supply

The power supply provides the regulated voltages necessary for the electrical circuits within the NBP cartridge. No electrical isolation is provided since the patient is connected to the cartridge through an insulating plastic hose.

2.10.10Power supply monitor

The power supply monitor circuit provides reset logic to the safety timer, redundant power switch circuit and digital circuits at power up and in the event of a power failure or voltage drop.

2.10.11Hose detection

An electromagnetic coil located at the hose connector detects the metal in the hose connector when the connector is present.

2.10.12Watchdog

As part of the pneumatic control, the communications watchdog is serviced. The watchdog servicing takes place at least every 0.47 seconds or the watchdog is activated, causing a shutdown of the pneumatics.

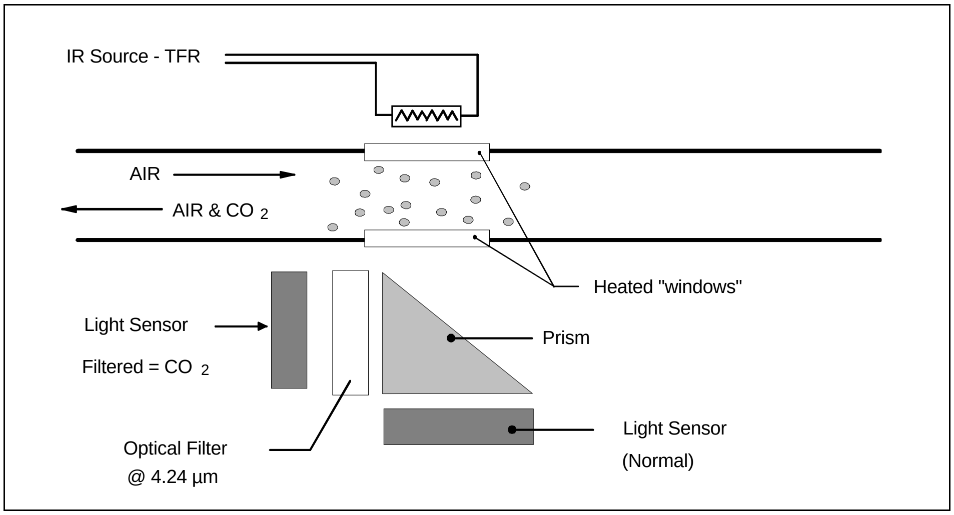

Fig. 2-14 etCO_2 Sensing Process Functional Block Diagram

2.11 etCO_2 Module

The etCO_2module non-invasively monitors end-tidal CO_2 using a technique that relies on the selective absorption properties of the CO_2 to specific frequencies of infra-red radiation. See Fig. 2-14.

In the sensor a thick film infra-red source is pulsed at a rate of approximately 87 Hz, generating a broad- band spectrum of IR. Selective filtering separates this into two narrow regions, one inside the band of CO_2 absorption, the other outside the region of CO_2 absorption. The detector associated with the filter outside the band of CO_2 absorption records the maximum level of the source energy since the signal it receives is not affected by CO_2. It provides a baseline which serves as a Reference for the level of CO_2 in the airway. The other detector senses a filtered energy level modified by the presence of CO_2. As the level of CO_2 increases, the CO_2 gas molecules in the airway absorb more of the light energy and less signal reaches the detector. This signal, converted by the detector, is referred to as the Data signal. Current through the thick-film source is bidirectional to offset the tendency of particles within the source to migrate when exposed to a strong unidirectional electric field caused by current flow only in one direction. This keeps the structure of the source uniform and enhances system integrity and life of the product.

To acquire a precise level of CO_2, both channels are simultaneously sampled and the level of CO_2 is determined from the ratio of the Data and the Reference channels. The ratio is compared to a look-up table in memory to establish the correct value in units of mmHg.

The module then sends the results to the SC9000 host system for further processing and display.

2.11.1 System Hardware

The module is a three-part system composed of a Digital Board, an Analog Board, and an Accessory Assembly. The Digital Board has two major functional areas: the power supply section and the bulk of the digital control logic. The Analog Board provides for data acquisition and conversion, and contains the servos for controlling the temperature of the case and detector heaters, and the source pulser used to control the probe. The Accessory Assembly contains the CO_2 sensor and the Calibrator (that contains the calibration switches and calibrator EEPROM).

2.11.2 System Memory

The system has three types of memory:

- PROM Programmable Read Only Memory
- SRAM Static Random Access Memory
- EEPROM Electrically Erasable Read Only Memory

PROM stores the module's program. Its contents remain intact even when power is removed from the module. It has been socketed to allow for future program updates, if required. While the PROM is in the system, the processor can only read from it. Besides containing the module's program, it also contains various look-up tables for calculating CO_2 parameters and the Interrupt Vector Table.

The system's Static RAM functions as a scratch pad to temporarily hold various system variables until they are either no longer needed by the system and are overwritten with new information, or power is removed from the module and the RAM contents are lost.

The EEPROM holds system parameter information that must be retained when power is removed, but must also be modifiable by the processor. The device contains multiple copies of system information such as calibration factors, sensor serial number, and span cell number, to ensure data integrity.

A Supervisor chip performs various monitoring tasks to ensure that the microprocessor and system run properly.

2.11.3 User Interface

The user interface provides capability for airway and adapter calibration, and also compensation for effects of N_2O and O_2. When calibrating the accessory assembly, switches inside the sensor, one for the Zero Cell and one for the Span Cell, tell the processor when the assembly has been placed on the proper cell for system calibration.

2.12 HEMO 2/4 POD

2.12.1 Functional Description

HEMO 2/4 PODs have provisions for monitoring either 2 or 4 invasive blood pressures, 2 temperatures and cardiac output. See Fig. 2-15

2.12.2 Pressure

The pressure data acquisition front end is designed to operate with resistive strain gage pressure transducers having an output impedance of less than 3000 Ohms and an input impedance between 2000 and 300 Ohms (see Fig. 2-16). Excitation voltage is applied, one at a time, to each resistive strain gauge pressure transducers by a single, current limited voltage reference circuit which is time-multiplexed across four pressure sensors. The differential output signals generated by the pressure sensors are passed through filter and clamp networks which limit the differential and common mode voltage swings and filter out RF noise.

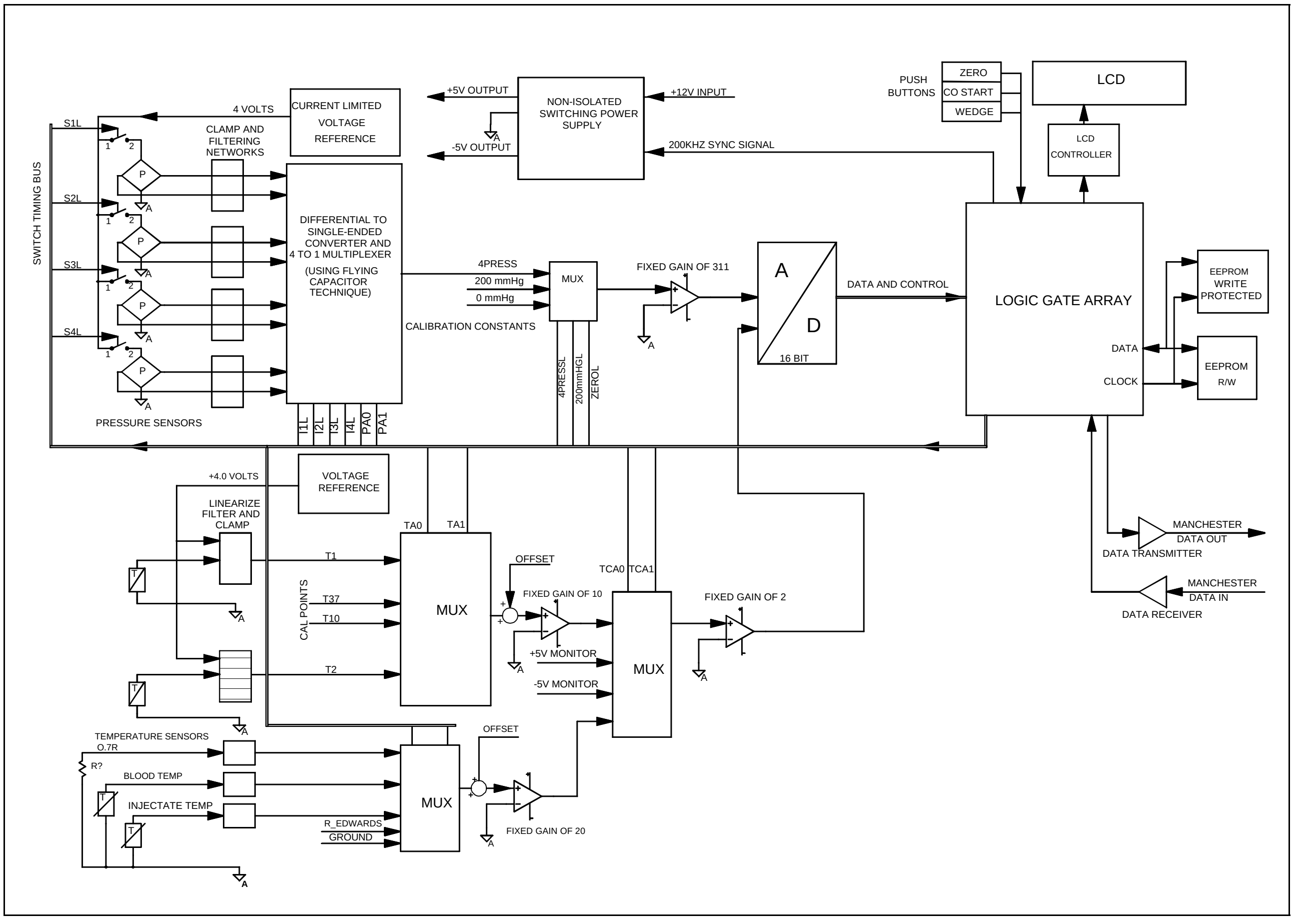

Fig. 2-15 HEMO 2/4 POD Functional Block Diagram

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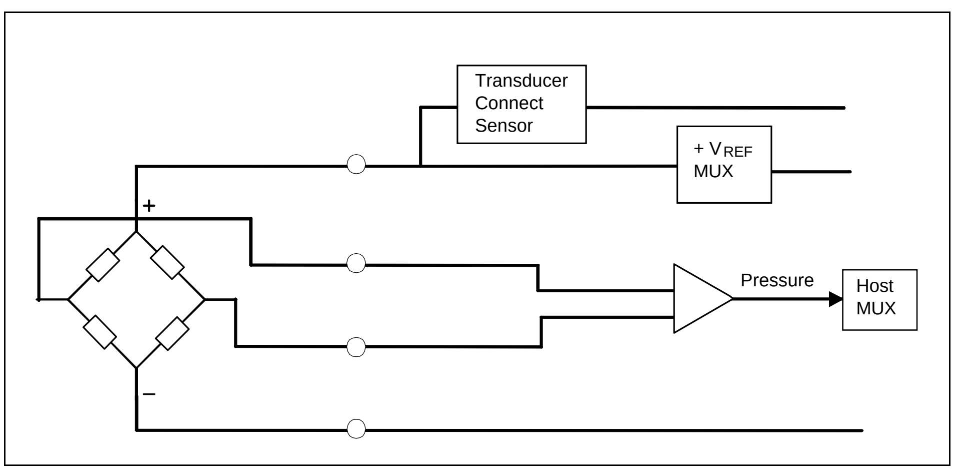

Fig. 2-16 IBP Functional Block Diagram

Next, the signals enter a functional block that converts the differential signals into single ended signals which are then presented one at a time in a time-multiplexed fashion to a fixed gain single ended amplifier. Calibration voltages for zero and 200 mmHg are periodically switched into the amplifier input to correct errors in amplifier offset and gain respectively.

A 16 bit A/D converter samples the resulting output voltage. Timing is coordinated by the logic gate array.

2.12.2.1 Temperature

Each of two thermistors is connected to a functional block that consists of a precision resistor network to partially linearize the voltage verses temperature transfer curve of the thermistor. This functional block also consists of means for filtering RF noise and limiting the voltage swing. A 4.5 Volt reference is connected to power each linearization network.

A multiplexer selects one of the two temperatures or one of the two calibration points and connects the voltage to the input of a fixed gain amplifier. The two calibration points are used to correct gain and offset errors in the amplifier circuits.

An offset is added to center the signal within the dynamic range of the A/D converter. The signal is then further multiplexed with two power supply voltage monitors and Cardiac Output. A fixed gain of two is finally applied to match the signal range to the full scale range of the A/D converter.

2.12.2.2 Cardiac Output

Cardiac output operates in much the same way as temperature. The thermistor signals are filtered and clamped then multiplexed to the input of a fixed gain amplifier. Two calibration voltages are also multiplexed in to correct amplifier offset and gain errors.

Next, an offset is added to the signal to center it to the dynamic range of the A/D converter. The amplified signal is then multiplexed with temperature, then through a fixed gain of two and finally to the A/D converter.

2.12.3 EEPROM Storage

Two EEPROM's are used for non-volatile information storage. One EEPROM is used for reading and writing data that changes during the operation of the POD, such as pressure offsets, the other stores more permanent information such as POD serial number and is therefore write protected. A state machine inside the logic gate array supports communications between the Host and the two EEPROM's. A mechanism is provided which allows service personnel to disable the write protection of the otherwise write protected EEPROM.

2.12.4 LCD and Push Buttons

A total of 16 LCD characters are provided for use as pressure labels. Each pressure channel is allocated 4 LCD characters. The Logic Gate Array supports communication of controll between the Host and the LCD's.

Up to three push buttons are provided for user interface. There is one for pressure zero, one for Cardiac Output Start and one spare. The interface of the buttons to the Host is handled by the gate array.

2.12.5 Current Limiting the Voltage Reference

In the event a defective pressure sensor presents a short circuit to the excitation voltage source, the voltage source goes into current limit during the bad transducer's time slot.

2.13 Remote Comm Subsystem Hardware

2.13.1 SC9000 Remote Communication Interface

The SC9000 Remote Bus interface to the CPS Network is a slave device with a dedicated address space. The responding devices, however, are in the CPS. Status bits indicate when the remote device is connected and powered up, and signal validity on the communication link. If a proper connect is established, a periodic poll is sent to the CPS to up-date the interrupt status to the monitor every 8 microseconds.

2.13.2 Connection Characteristics

Two mechanisms are used to verify the physical attachment of a docking station.

- First, a hardwired signal between the monitor and CPS is activated when a cable connection is achieved. This signal is valid even if the CPS is powered off.
- Second an opto-isolator is activated when a powered CPS is attached to the monitor. A current loop is established by current flowing thru the receive lines, opto-isolator and transmit lines.

A time filter is applied to both functions, such that the function must be valid for a minimum of 100ms before activating. Deactivation is immediate.

2.13.3 Analog Monitor (ADC838)

The analog monitor can measure local signals to 8 bit resolution. Two channels are dedicated to sense the environment (internal temperature and external light intensity). The remaining six bits provide feedback of the power supply voltages and analog signals. All input signals are scaled to be within the 0 to 5v range of the converter.

2.14 CPS

The SIRENET CPS contains a data communications network controller and a power supply. It supplies power and communications interface for either an SC9000 or an SC6000 patient monitor, and for peripheral devices associated with the monitors.

The INFINTYNET CPS substitutes connectivity to SIRENET with connectivity to the INFINITY Network. In addition it supports two RS232 ports, access to both CPS diagnostics and Host diagnostics, and support for a passive remote display.

2.14.1 Network Board Hardware

The major circuits include a high speed serial link to the SC9000, control and status registers to the 68302 and 8344 processors, and miscellaneous functions. The serial link functions as a bus master on the local bus. The 68302 performs bus arbitration (and provides a serial channel for communication with an SC6000). The registers and miscellaneous functions are slave devices on the bus and are completely accessable to the 68302.

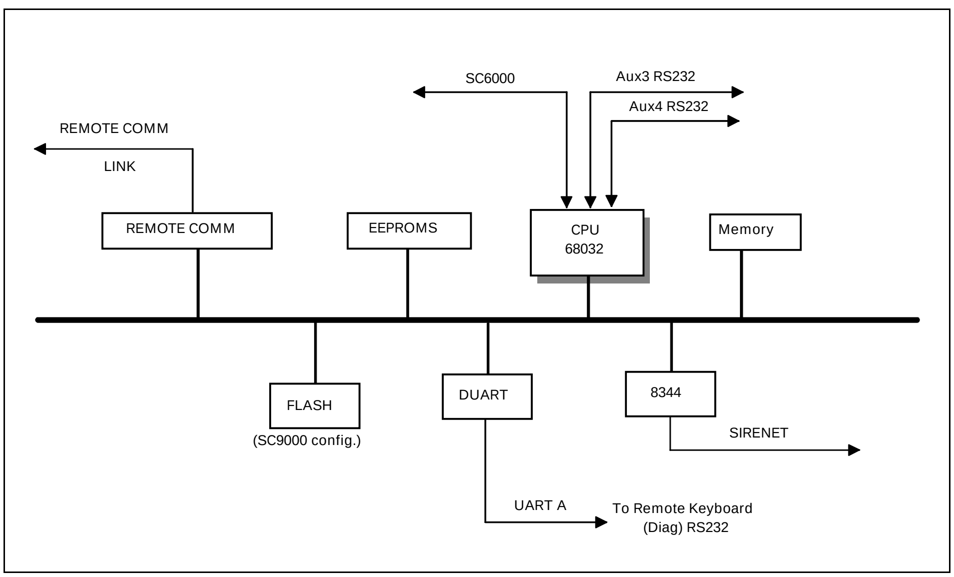

Fig. 2-17 SIRENET CPS Communications Functional Block Diagram

Motorola 68302 CPU

The Motorola 68302 CPU serves as the processing engine for the SC6000 serial port link. The 68302 CPU runs at a frequency of 20MHz, and is connected to the CPS Bus. It accesses the FLASH (its code space) and the 68302 External RAM (its data space) via the CPS Bus.

FLASH memory is used for storage and execution of the 68302 software, and also to store care unit specific setups. The 68302 executes its code directly out of the FLASH, and is accessible from the CPS Bus to provide the ability to program it with new software from an SC9000 monitor.

Serial Communication Controller - SC6000 Link

A serial communications channel of the Motorola 68302 CPU, “SCC1”, provides a serial link between the CPS and SC6000. This link uses the HDLC protocol and operates at a rate of 2 MBit/sec. “SCC1” is used for this link since it is the highest priority channel in the 68302.

Serial Communication Controller - User Interface

“SCC3” of the Motorola 68302 CPU provides a diagnostic user interface, to run embedded diagnostics on the CPS hardware and trace CPS operations during software analysis and debugging sessions. “SCC3” is used with a UART baud rate of 19.2K.

External RAM is used for software downloader code, runtime stack, SCC data buffers, monitor configuration data and error logs.

Intel 8344 Microcontroller

The Intel 8344 serves as the processing engine for the SIRENET network link, and runs at a frequency of 12MHz. The 8344 has a local bus from which it accesses the 8344 SRAM and shared memory (see below). Access to this bus is immediate since the 8344 does not have any bus arbitration mechanism.

An external FLASH chip located on a local bus connected to the 8344 is used for 8344 code execution. The FLASH chip is accessible via the CPS Bus so that it can be upgraded with new software from the SC9000 monitor.

Shared Memory (SHRAM)

A shared random-access memory, accessible by the SC9000, the CPS 68302 CPU, and the CPS 8344 Microcontroller, supports the SIRENET network interface. This memory is dual-ported, and is accessible via the CPS Bus and the 8344 Bus. A multiplexor controls the selection of the bus to which SHRAM is connected at any given time.

Monitor Connection Characteristics

The network board communicates with the attached monitor either by the SC9000 high speed serial link or by the 68302 serial channel (for an SC6000). Because of the different characteristics of each type of link, relays are used to select one or the other. (The default selection is the SC6000 link.) If an SC9000 unit is detected, the relays switch to the REMOTE COMM type link. A time filter is applied to each signal, such that the function must be valid for a minimum of 64 milliseconds before activating. Deactivation is immediate.

A hardwired signal between the monitor and CPS is activated when a cable connection is achieved. This signal is valid even if the monitor is powered off. For an SC9000 monitor, a current loop is established by current flowing thru the transmit lines, opto-isolator and receive lines. A voltage comparator activates when the loop is sensed. The link is generated when a receive signal is sensed by the T1 receiver.

The connection state of the monitor is defined as

- SC6000 Docked
- SC9000 Docked
- No Monitor
- Error
- Transitional

NOTE: If the transitional state persists for greater than one second, a faulty docking or error condition exits

2.14.2 HW/SW Interface

The SIRENET CPS is an independent processing unit that provides the connection between the SC9000 (or SC6000) monitor and the SIRENET network. The CPS provides only a single patient monitor connection to the SIRENET at any given time. This means that only one monitor, either an SC9000 or SC6000, may be connected to the CPS at any given time.

2.14.3 Pick-and-Go Operation

This feature provides the SC9000 and SC6000 monitors with the ability to be “disconnected” from the CPS during operation, while preventing the central station from going into an “alarm” condition. This feature is provided by special hardware and software in the 8344 microcontroller on the CPS, which basically communicates with the central station on the SIRENET network (on a limited basis) in the absence of SC9000 and SC6000 monitors.

2.14.4 EEPROMs

The CPS contains four SERIAL EEPROMs which are programmed in the factory with various configuration parameters related to the CPS. One contains factory-programmed field service data and is read-only in the field. A second EEPROM is field-programmable and contains various configuration parameters associated with the CPS.

2.14.5 Power Supply

The CPS power supply not only powers the network controller in the CPS but also powers the SC9000 (or SC6000) patient monitor and up to two auxiliary units. It is a line powered switching power supply capable of operating over the range of international line voltages without having to be reconfigured. Manual switching or fuse changing are not required.

The power supply provides a regulated +13 VDC at 7 amps to the SC9000 (or SC6000) monitor via the docking station, and at 2.3 amps to each of 2 auxiliary docking stations. The auxiliary docking station outputs are current limited for fault isolation. A DC to DC converter connected to the +13 VDC output provides a regulated +5 VDC and ±12 VDC for the network board. A fan speed control circuit is also provided for cooling the CPS unit.

To eliminate ground potential difference due to the return current in the SC9000 docking station cable, the +13 VDC output has a 500 VRMS isolation from earth ground. This isolation is maintained also in the DC to DC converter for the +5V, ±12V outputs. An earth ground connection is made to the SC9000 monitor at the docking station for EMI suppression via the docking station cable shield. The units connected to the auxiliary docking stations will have ground isolation in their DC to DC converters to eliminate ground potential differences.

The power supply uses a soft switching (quasi-resonant) square wave forward converter topology operating at 500 Khz. No power factor correction is provided.

Fuses (not user accessible) have the following approvals; UL recognized, Semko approved, CB certified, BSI approved.

Chapter 3

Repair

3.1 Introduction

This chapter describes how to disassemble an SC 9000 Patient Monitor, replace parts and subassemblies that Siemens has identified as field-replaceable (see Appendix A), and reassemble the monitor. The structure of an SC9000 consists of a base unit with attachable modules and pods. Specific peripheral devices, such as the CPS and the SC 9015 are are also part of a fully functional SC9000 system.

WARNING:Always functionally verify proper operation of the monitor after the monitor has been opened and then reassembled, before returning the monitor to clinical service.

3.2 Service Policy and Replaceable Parts

Qualified service personnel may replace the following specific items / sub-assemblies in the field. Component-level repairs should not be attempted, and will void any warranty or exchange allowance for returned subassemblies. A complete list of replaceable components and part numbers is given in Appendix A.

3.2.1 Base Unit

Display Backlight (9.5”, 10.4”)

Internal Ni-Cd Batteries

Optical Encoder Subassembly, Rotary Knob

Speaker Subassembly

Front Panel Board Subassembly

Main Processor Board Subassembly

Power Conversion Board Subassembly

Front End Board Subassembly

3.2.2 R50 Recorder

Front bezel

Printer subassembly

A100 PC Board

3.2.3 Modules, PODs, and Peripherals

The following modules, PODs, and peripherals have no field-replaceable parts or subassemblies.

- NBP Module
- $etCO_2$ Module
- CPS
- HEMO4 POD / HEMO2 POD
- SC9000 Battery Module
- SC 9015 Remote Display
- Fast Battery Charger
- Memory Card

3.3 Safety Precautions

Remove all power sources, including the internal Ni-Cd batteries, and any attached modules and cables, before attempting to open the monitor case.

Disconnect all power sources and cables from any module, POD or peripheral device, before attempting to service the device.

> ***CAUTION:*** Open SC9000 monitors only in a static-protected environment. Observe standard procedures for protecting the equipment from static electricity.

3.4 Replaceable Parts and Subassemblies NOT Requiring Disassembly of Monitor

The rotary knob, front panel language label, foot pads, and Ni-CD batteries can be replaced without disassembling the monitor.

3.4.1 Replacing the Rotary Knob

The rotary knob is press fitted onto the metal shaft of the optical encoder subassembly, and once removed, should not be reinstalled. It **must** be replaced.

To remove the knob, grip it **very** firmly with vise-grips or a similar tool, and pull it straight out and off of the metal rod. Avoid turning the knob in the process.

To install a new knob, firmly press the knob onto the shaft.

3.4.2 Replacing the Language Label

Replace the Language Label as follows:

1) Carefully peel up one corner of the label and pull it towards the opposite corner. Take care not to remove or damage the underlying membrane keypad.
2) Peel the protective covering from the section of the new label under the function keys.
3) Position the label on the membrane keypad so that it fits squarely in the label depression allowance on the front bezel, and using a sweeping or rolling motion to prevent air bubbles from becoming trapped under the label, press on the label to secure it to the membrane keypad.
4) Remove the protective covering from the remainder of the language label, and with a similar motion affix the label along the bottom of the bezel.

3.4.3 Replacing Foot Pads

Two feet are on the bottom of the Front Panel Subassembly, and two are on the bottom of the Rear Housing. The pads are secured in the foot wells with adhesive. Replace the pads as follows:

1) Remove all remnants of existing pad and adhesive from foot well.
2) Remove protective covering from adhesive surface of replacement pad.
3) Position replacement pad in foot well, and press firmly on pad to secure in well.

3.4.4 Removing / Installing Ni-Cd Batteries

The Ni-Cd batteries are contained in two compartments accessible from the rear of the monitor. Compartment covers are secured to the rear housing by flexible plastic locking tabs. Remove the covers to access the batteries. See Fig. 3-1 and also Fig. 3-13.

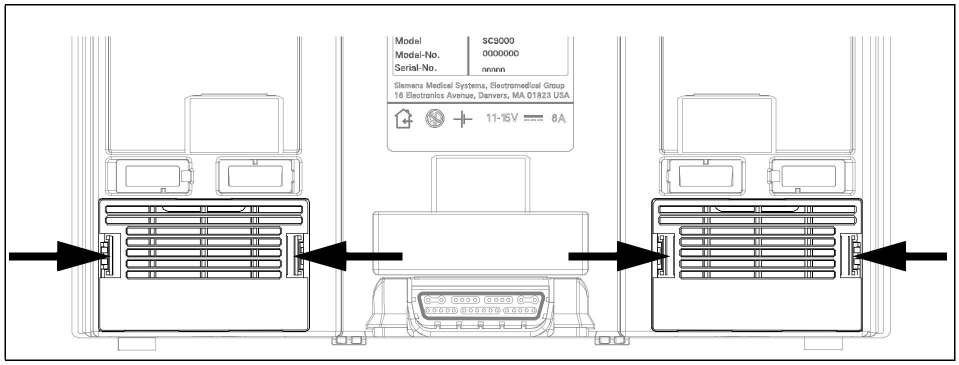

Fig. 3-1SC9000 Rear View - Ni-Cd Battery Compartments - Release Tabs for Compartment Covers

Removing Batteries

1) To remove Ni-Cd battery compartment covers, squeeze tab pairs together in direction of arrows shown in Fig. 3-1, and pull covers straight out from rear housing.

2) Lift outer side of each battery pack so as to position pack diagonally across rectangular compartment as illustrated in Fig. 3-2.

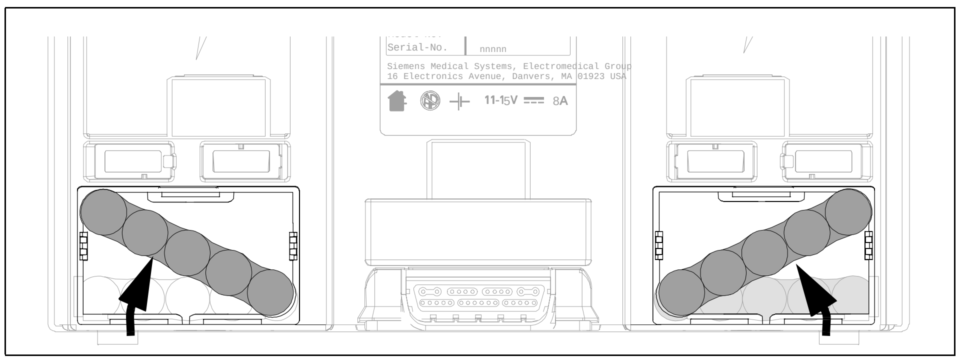

Fig. 3-2Removing Ni-Cd Battery Packs

3) Pull battery packs straight out of compartments, and disconnect battery cables. **Note orientation of cabling and connectors**, for reinstalling batteries.

NOTE: The battery cable connectors have plastic locking tabs on the connector housings that need to be released in order to separate the two parts of the connectors.

(Re)Installing Batteries

Reverse steps 1 to 3 to install Ni-Cd batteries and battery compartment covers.

NOTE: The batteries fit very snugly, and may require a little manipulation to seat them in the compartment. Also, in some monitors, a shelf along the back of the battery compartment prevents the batteries from sitting flat in the compartment. **Replace batteries in pairs. Be sure both battery packs have identical serial numbers**.

3.5 Preparing Monitor For Disassembly

Remove all attached modules, unplug all cables, disconnect all external power sources, and remove the internal Ni-Cd batteries from the monitor.

3.6 Opening Monitor

To open the monitor, it is necessary to first remove the left and right side panels. The panels are each secured to the monitor housing with several locking tabs and a pressure-sensitive latch. Remove the panels as follows:

3.6.1 Removing Left Side-Panel

1) Insert a PCMCIA card into memory card slot to force ejection button out.

2) Remove and save ejection button cover.

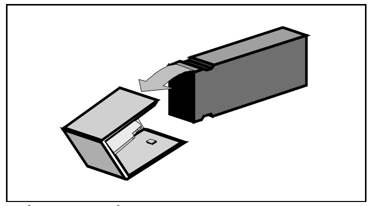

Fig. 3-3Ejector Button Cover Removal

1) To remove cover, grasp front and back sides of button cover between your thumb and forefinger, squeeze cover slightly, and **carefully** rock cover off of shaft in direction of arrow shown in Fig. 3-3.

WARNING:The button cover has nubs that grip grooves in the top and bottom sides of the shaft, as illustrated in the figure. Grasping the button by the top and bottom sides tends to increase the effectiveness of the nubs. The increased force required to remove it can pull the shaft completely out of the ejector mechanism, requiring depot repair of the monitor.

2) Push ejection shaft back in, and remove PCMCIA card.

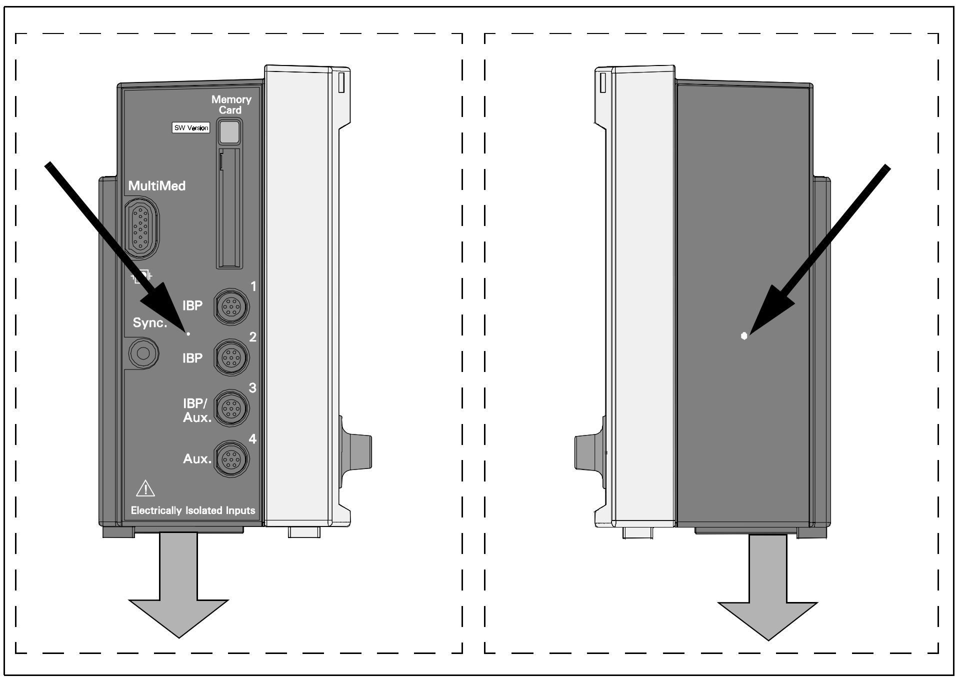

Fig. 3-4Removing Left and Right Side-Panels

3) Press firmly on dot on lower center of panel between IBP1 and IBP 2 (see Fig. 3-4), to release latch.

4) While pressing on dot, slide panel downward to release locking tabs, and remove it from monitor.

3.6.2 Removing Right Side-Panel

1) Press firmly on dot on lower center of panel (see Fig. 3-4).

2) While pressing, slide panel downward to release locking tabs, and remove it.

3.6.3 Separating Front Panel From Rear Housing Subassemblies

1) Turn monitor upside down, with back of monitor facing you.

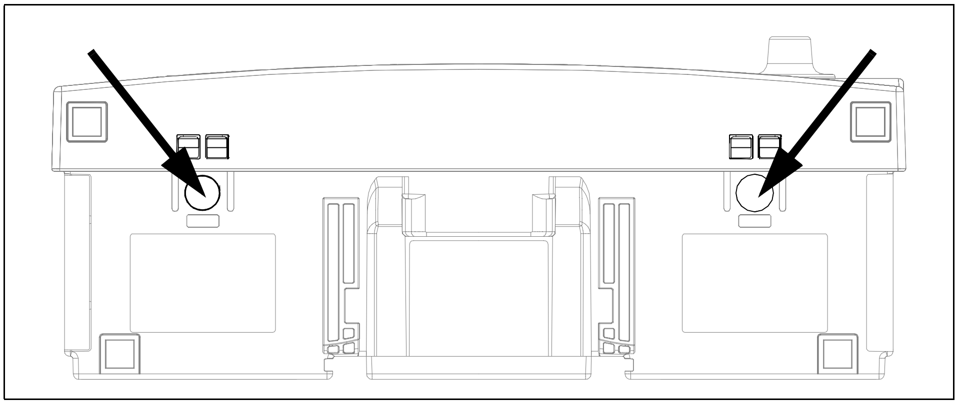

Fig. 3-5Front Panel Latch Release Pressure Points on Bottom of Monitor

2) Press down firmly on thumb depressions on bottom of monitor (see Fig. 3-5) to release front panel latches, and slightly separate bottom of front panel subassembly from rear housing.
3) Return monitor to its proper upright position, with back of monitor facing you.

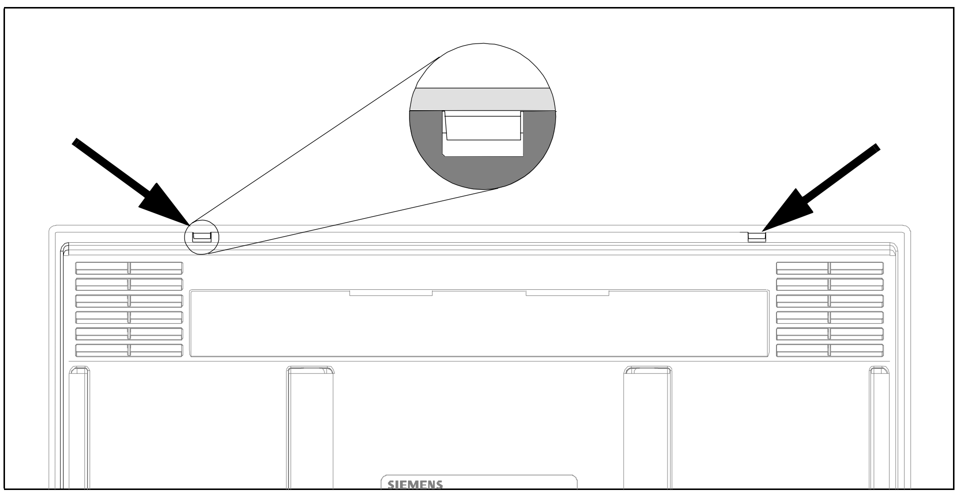

Fig. 3-6Front Panel Latch Release Slots on Top of Monitor

4) Insert tip of small screwdriver into each of two release slots on top of monitor (see inset in Fig. 3-6), as you apply a slight tension between front panel subassembly and rear housing, to disengage locking tabs and slightly separate top of front panel subassembly from rear housing.
5) Turn monitor around so that display is facing you, and carefully separate two subassemblies. Pull front panel subassembly straight off of rear housing until positioning guides on four corners of front panel just clear housing.

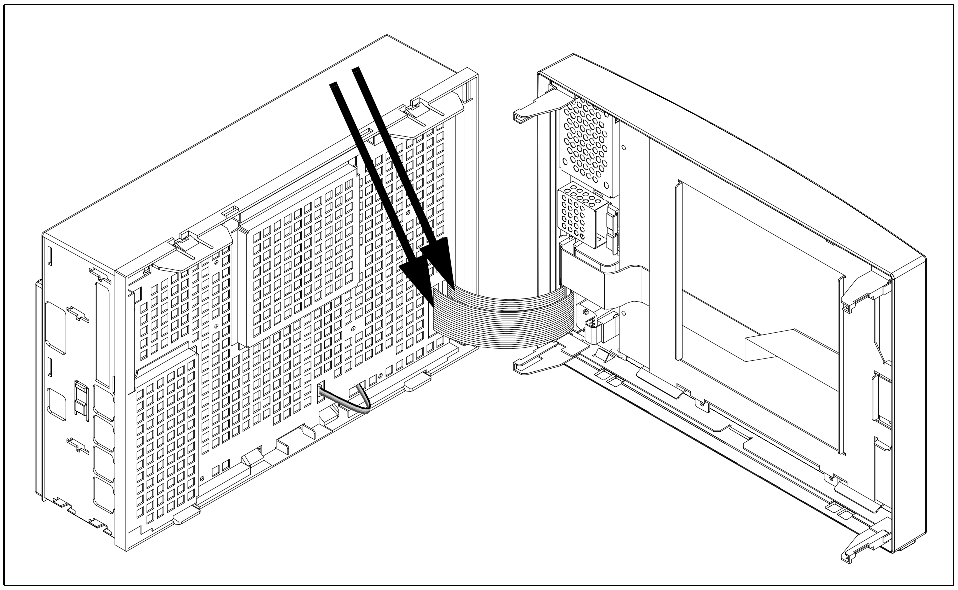

Fig. 3-7Opening Monitor

6) Pull front panel subassembly straight out from rear housing to separate the two subassemblies about 2” (5cm), and then swing front panel subassembly away from rear housing carefully, as illustrated in Fig. 3-7.

7) Unplug two ribbon cables interfacing rear housing and front panel subassembly, at lower left hand corner of rear housing subassembly, as indicated by arrows in Fig. 3-7, to completely separate subassemblies.

3.7 Closing Monitor

1) Refer to Fig. 3-7. With rear housing and front panel subassemblies in upright position, rear housing subassembly on left and internal circuits facing you, plug in two ribbon cables at lower right hand corner of rear housing and left hand corner of front panel subassembly.

2) Position front panel subassembly such that guides on corners are partially inserted into guide-channels in four corners of rear housing subassembly.

3) Turn partially assembled monitor backside down, and carefully press two subassemblies together until four locking tabs on rear housing (two on top and two on bottom) seat properly in front bezel and lock subassemblies together.

4) Slide left and right side panels into position on rear housing so that locking tabs and latching tab are properly seated.

5) Reinstall ejection button cover.

NOTE: The button cover is not centered on the shaft, and can be installed in only one orientation.

6) Reverse steps of section 3.4.4 to reinstall Ni-Cd batteries and battery compartment covers.

7) Functionally verify proper operation before returning monitor to clinical service.

3.8 Replacing Subassemblies in Front Panel Subassembly

The Front Panel Subassembly has been manufactured with several slightly different layouts, two of which are illustrated in Figures 3-10 and 3-11. The 9.5” Front Panel Subassembly is illustrated in Fig. 3-8. Procedures for accessing the various replaceable subassemblies in the Front Panel Subassembly, however, are essentially the same for all layouts. Replaceable subassemblies contained in the Front Panel Subassembly include the following:

- Fluorescent Backlight(s) (A')
- Speaker Subassembly(B)
- Optical Encoder Subassembly (C)
- Front Panel Board Subassembly (D)

In addition, the front bezel without the LCD screen and other subassemblies is replaceable as an independent subassembly. The Front Panel Subassembly is also replaceable in its entirety as a complete subassembly.

3.8.1 Replacing Backlight and LCD Display Subassemblies

When viewing display from front of monitor, the backlight is located behind LCD screen in Front Panel Subassembly. In the 9.5" display, the backlight (A' in Figure 3-8) is a self-contained subassembly that mounts behind the display subassembly. In the 10.4" display two separate fluorescent tube subassemblies (A' in Figure 3-11) mount behind the display at the top and bottom of the display subassembly.

Removing Backlight

Backlight is held in position in the Front Panel Subassembly by a metal positioning/ retaining frame in the 9.5" display subassembly, and by four Phillips-head screws (two in each backlight) in the 10.4 " display (see Figures 3-8 through 3-11).

1) With Front Panel Subassembly separated from rear housing and laying face down on smooth clean surface, remove two Phillips-head screws ③ at bottom of positioning/retaining frame ④.
2) To remove retaining frame --
   - On the 9.5" display subassembly, lift up the bottom of the frame until it just clears the backlight subassembly. Carefully pull the frame toward the bottom of the front bezel to slide the locking tabs ⑤ at the top of the frame out of the retaining slots, and remove the frame.

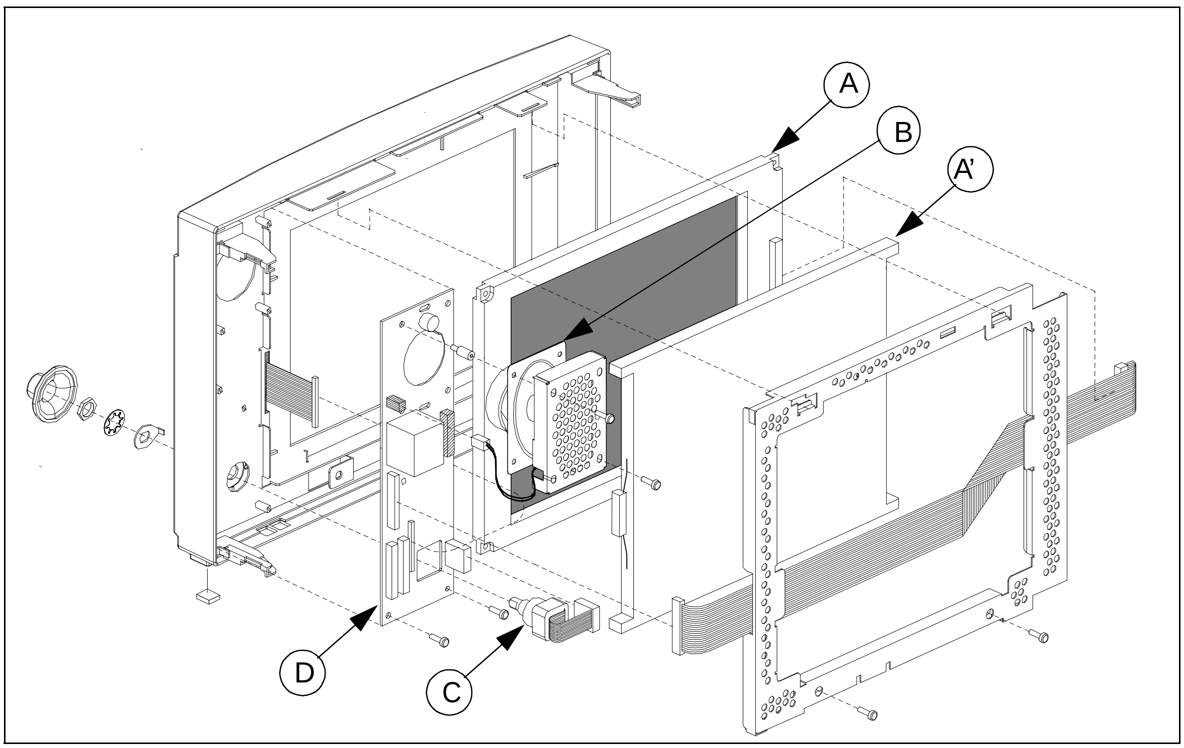

Fig. 3-8Front Panel Subassembly Exploded View, 9.5" LCD Display

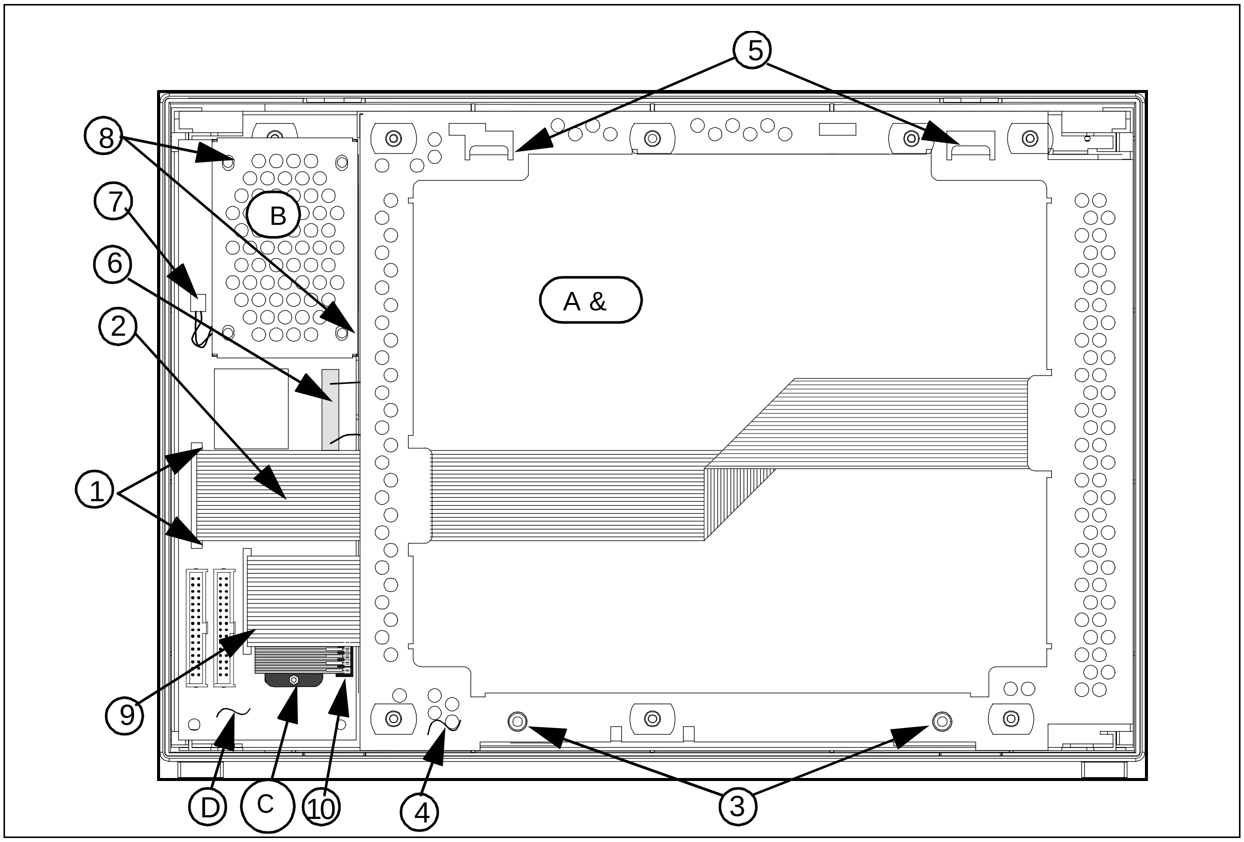

Fig. 3-9Front Panel Subassembly Layout - 9.5” LCD Display

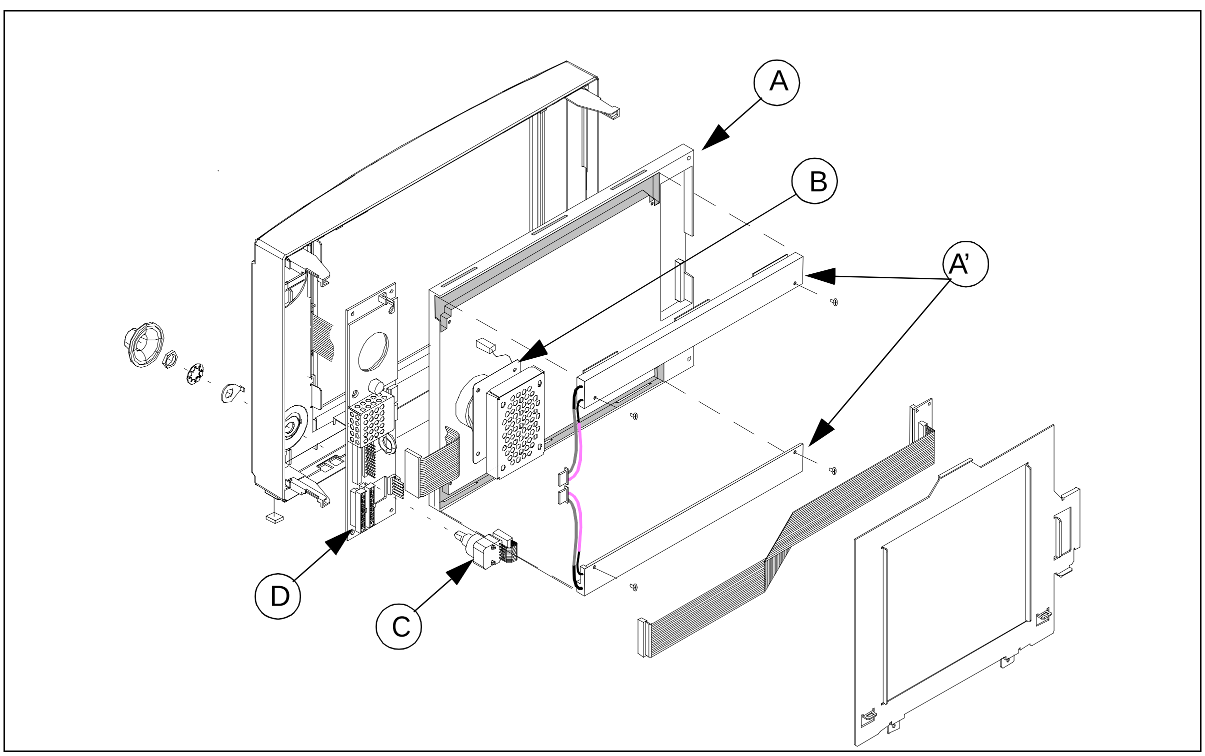

Fig. 3-10Front Panel Subassembly Exploded View - 10.4” LCD Display

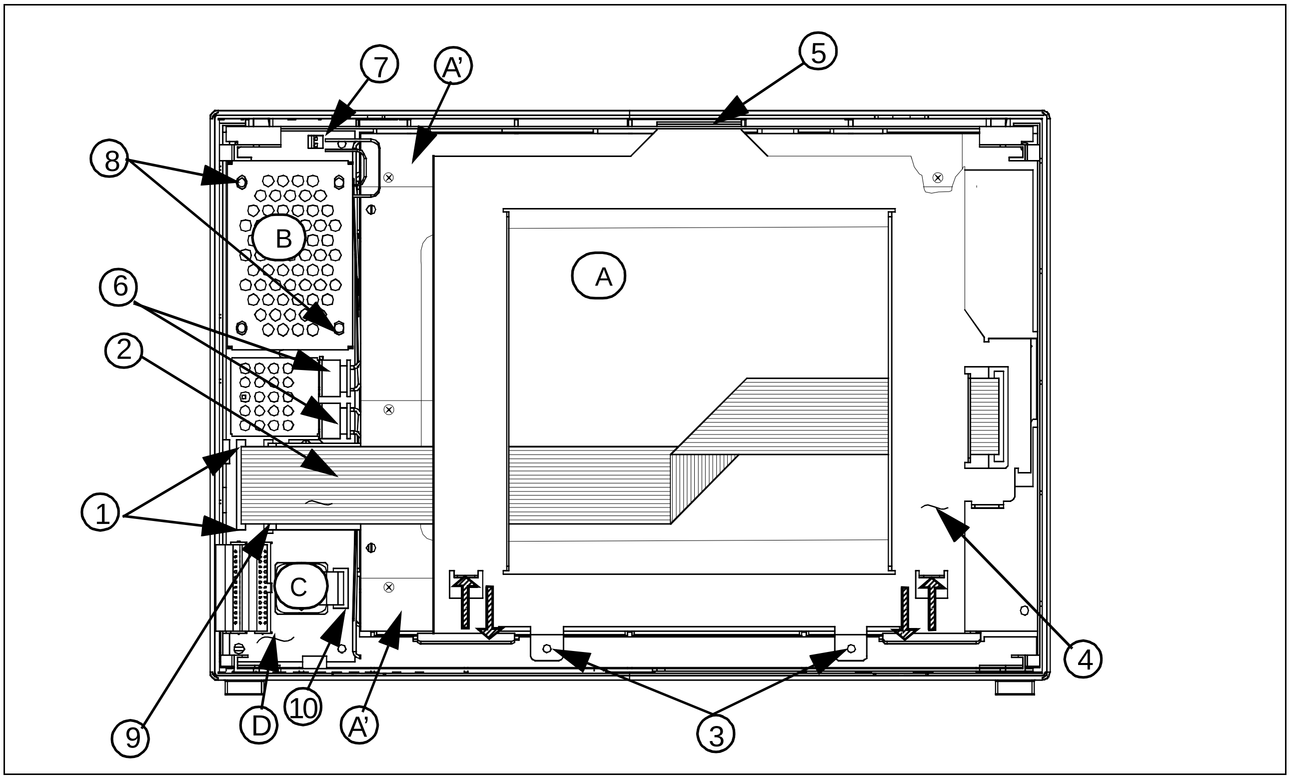

Fig. 3-11Front Panel Subassembly Layout - 10.4” LCD Display

- On the 10.4” display subassembly, depress the tabs on the bottom of the front bezel frame (⇓) , one at a time while applying pressure on the retaining frame tabs (⇑). to release the retaining frame from the front bezel frame. Then lift the retaining frame at the bottom to release the lip on the locking tab at the top and remove the frame.

3) Lift the lock on the board-mounted LCD ribbon connector ① and slide the ribbon ② out of the connector.

   NOTE: It is not necessary to disconnect the front panel switch membrane ribbon cable connector ⑨ from the PC board.

4) Unplug the high-voltage cable ⑥ from the backlight connector (white) at the left of the backlight.

   NOTE: On the 10.4” backlight, there is a separate high-voltage cable for each fluorescent tube.

5) Lift the Backlight Subassembly(s) out of the Front Panel Subassembly.

Removing/ Reinstalling the LCD Screen and Display Subassembly

The LCD screen, **A**, is permanently encased in a metal frame that fits snugly into the metal frame of the front bezel. After removing the backlight(s), to remove the LCD screen carefully pry the encasing frame up from the front bezel frame, and lift the LCD screen out. When installing the screen into a new bezel, carefully press the screen into place with an even pressure to avoid possible damage to the screen. When reinstalling the backlight(s), be sure that the wires of the high-voltage cable(s) are properly aligned between the backlight positioning/retaining frame and the frame on the LCD screen.

6) Reinstall the securing screws, and reassemble the monitor (see section 3.7).)

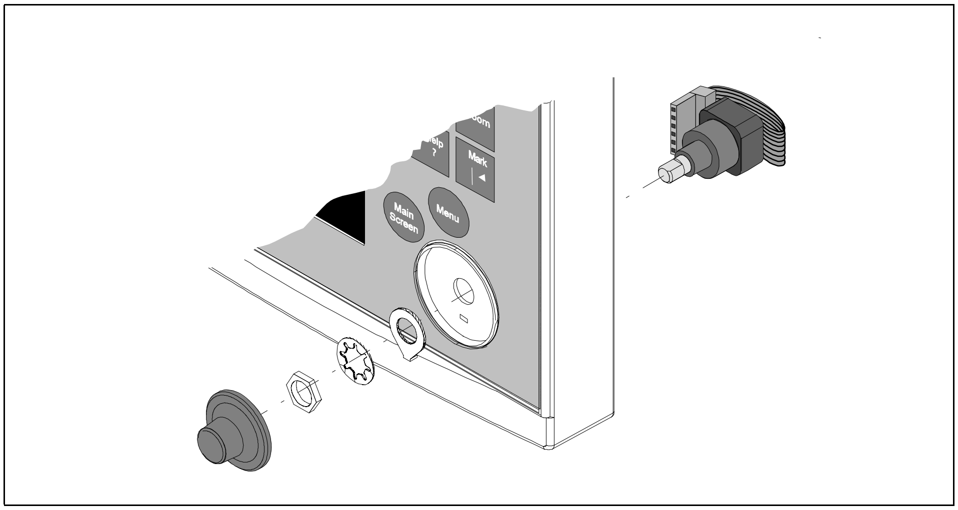

Fig. 3-12Optical Encoder Subassembly Installation

3.8.2 Replacing the Optical Encoder Subassembly

1) Remove the rotary knob. See section 3.4.1.
2) With the Front Panel Subassembly separated from the rear housing and laying face down on a smooth clean surface, unplug the membrane switch pad ribbon cable ⑨ from the PC board. Refer to Figure 3-9 (9.5" display) or 3-11 (10.4" display) as appropriate.
3) Unplug the optical encoder ribbon cable ⑩ from the PC Board.Unscrew the securing nut on the front bezel to remove the rotary switch subassembly (see Fig. 3-12).
4) Position the new Optical Encoder Subassembly in the front bezel, oriented so that the ribbon cable connector can be properly plugged into the connector on the PC board.
5) Secure the subassembly to the bezel as illustrated in Fig. 3-12.
6) Plug in the optical encoder and the membrane switch pad ribbon cable connectors.
7) Press a new knob onto the switch shaft, and reassemble the monitor (see section 3.7).

3.8.3 Replacing the Speaker Subassembly

The Speaker Subassembly (B) is mounted in the upper left hand corner of the Front Panel Subassembly. Refer to Figure 3-9 (9.5" display) or 3-11 (10.4" display) as appropriate. The speaker's magnet is pressed into a well, and the speaker is secured by two screws on diagonally opposite corners of the metal protective shield. Remove the Speaker Subassembly as follows:

1) With the Front Panel Subassembly separated from the rear housing and laying face down on a smooth clean surface, unplug the speaker cable connector ⑦ from the PC board.
2) Remove the two securing screws ⑧ and carefully lift the speaker and shield out of the subassembly.
3) Orient the replacement speaker in the well so that the speaker cable plug is by the speaker connector on the PC board.
4) Position the speaker shield so that the speaker cable is dressed through the slot provided in the cover.

5) Reinstall securing screws and plug speaker cable into connector on front panel PC board.

6) Reinstall Front Panel Subassembly onto rear housing, and functionally verify proper operation of the monitor.

3.8.4 Replacing the Front Panel PC Board

1) With the Front Panel Subassembly separated from the rear housing and laying face down on a smooth clean surface, unplug the speaker cable connector ⑦, backlight high-voltage cable connector(s) ⑥, membrane switch ribbon cable connector ⑨, and optical encoder cable connector ⑩ from the front panel PC board.

2) Lift the cable lock ① and unplug the LCD ribbon cable ② from the board-mounted connector on the front panel PC board.

3) Remove the speaker.

4) Remove the four securing screws, one in each corner of the front panel PC board, and lift the board out of the Front Panel Subassembly.

5) Reverse steps 1 - 4 to install a replacement front panel PC board.

3.9 Replacing Subassemblies in Rear Housing Subassembly

Replaceable subassemblies and components contained in the Rear Housing Subassembly (see Fig. 3-13) include the following:

- Main Processor Board Subassembly ①
- Power Conversion Board Subassembly ②
- Fans ③
- Front End Board Subassembly ④
- Ejector Button Cover ⑤
- Left ⑥ and Right ⑦ Side Panels
- Ni-Cd Batteries ⑧
- Ni-Cd Battery Compartment Covers ⑨

Other, ancillary non-replaceable components in the rear housing Subassembly include the housing itself [A], the metal RFI shield [B], and the conductive plastic RFI cage with attached non-conductive plastic chassis [C].

3.9.1 Integrated Subassembly

Subassemblies ① through ④ and RFI shields [B] and [C] in Fig. 3-13 are interconnected into one integrated subassembly that can be removed from the rear housing as an independent subassembly. Remove the integrated subassembly from the rear housing, except as otherwise directed, to access any of the replaceable subassemblies.

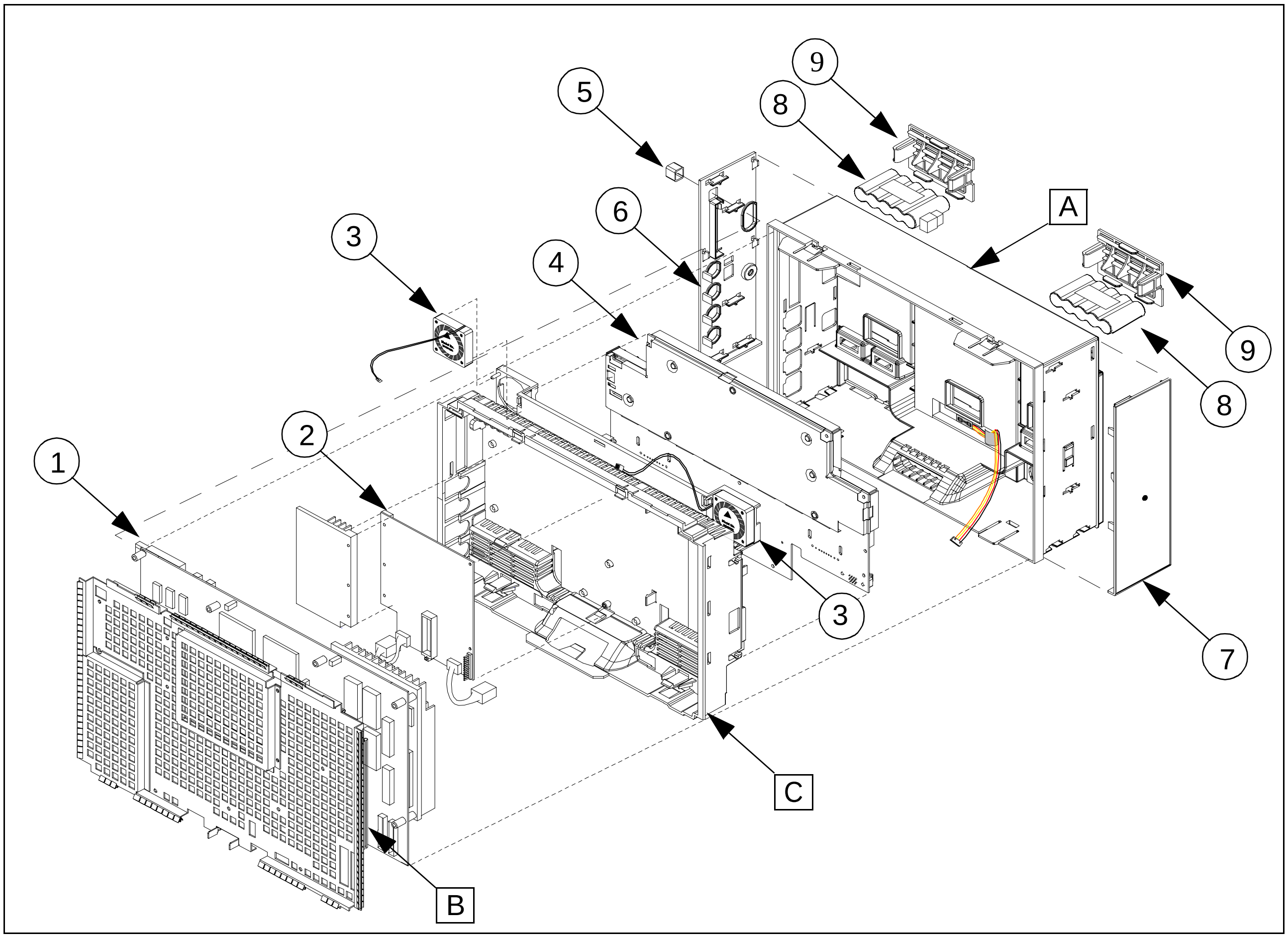

Fig. 3-13Rear Housing Subassembly - Replaceable Subassemblies

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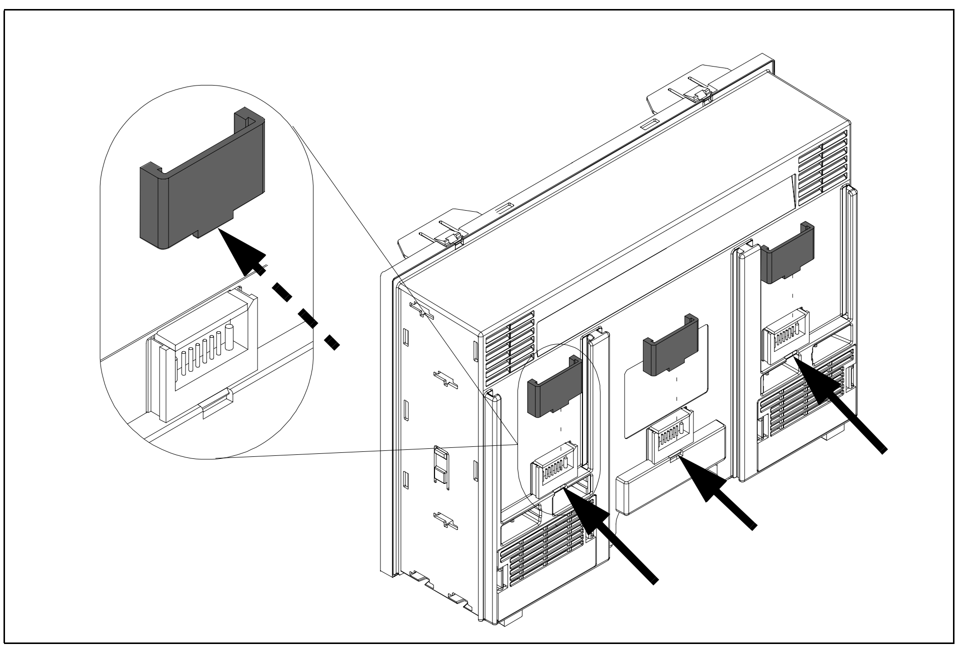

Fig. 3-14Slide-Lock Covers On Rear Housing Connectors

3.9.1.1 Removing the Integrated Subassembly

The integrated subassembly is secured in position in the rear housing by four locking tabs on the RFI cage (two in the top of the rear housing near the front panel locking tabs and two in the bottom of the housing by the thumb depression tabs, indicated by the heavy arrows in Figure 3-18), and by three slide locks that also cover the connectors for the main battery, NBP module, and $etCO_2$ module on the back of the rear housing. See Fig. 3-14.

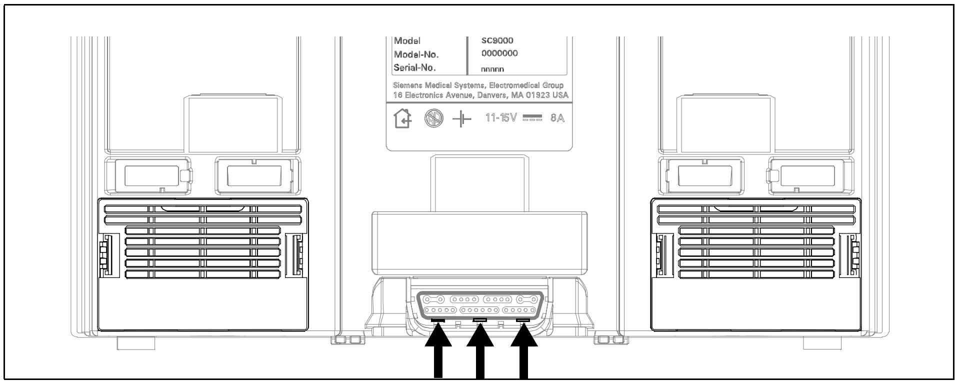

Fig. 3-15Location of Spring-Tabs on Docking Station Connector

There are also three flat spring-tabs on the bottom of the metal shield of the docking station connector, that secure the connector to the sides of the connector port in the rear housing. These spring-tabs prevent any movement of the connector and guarantee good electrical connection when the monitor is placed on a docking station. See arrows in Fig. 3-15. After the locks described in the paragraph above have been released, the three spring-tabs must be depressed simultaneously to permit the connector to slide out of the connector port.

1) Open the monitor following the procedures given in sections 3.5 and 3.6.
2) Unplug the 4-pin ID chip connector from the Processor Board, near the bottom of the metal RFI shield, and feed the connector and cable back through the rectangular access hole in the shield. See arrows in section of RFI shield shown in Fig. 3-16.
3) Lie the rear housing subassembly open-side down on a clean flat surface.
4) Slide the tip of a small common-blade screwdriver under the tab on each of the three connector covers (see arrows in Fig. 3-14). Lift each tab slightly to release the tab-lock, and slide the covers off of the connectors (see insert in Fig. 3-14).
5) Turn the housing top-side down.
6) Insert a screwdriver into each of the locking tab slots in the bottom of the housing near the thumb depression tabs and use a prying action to release the tab locks.
7) Turn the housing top-side up, and release the metal locking tabs in the top of the housing near the plastic front panel locking tabs.
8) Simultaneously depress the spring-tabs on the metal shield of the docking station connector as you push the connector slightly out of the connector port.
9) Holding the rear housing by the sides so that the open side is facing you, reach around the housing with your fingers and press on the NBP and $etCO_2$ connector housings to separate the integrated subassembly from the rear housing.

10) Carefully observe routing of the ID chip cable (to enable the cable to be identically routed during reassembly), and free the cable from the integrated subassembly.

11) Remove integrated subassembly from housing, and set on an anti-static mat.

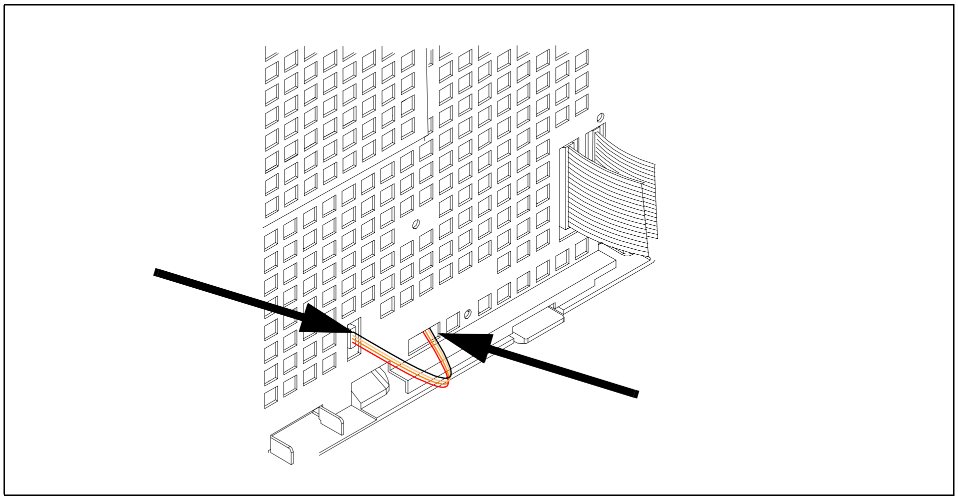

Fig. 3-16ID Chip Connector and Cable

3.9.1.2 Installing the Integrated Subassembly

1) Route the ID chip cable through the slot provided for the power cable from the power conversion board to the front end board.

   NOTE: It may be necessary to remove the metal RFI shield and use tweezers or a similar tool to grasp the ID chip cable connector, and then reinstall the shield before routing the cable through the slot and plugging in the connector.

2) Reposition the integrated subassembly in the rear housing so that the locking tabs snap into place in the top and bottom of the rear housing.

   NOTE: Keep a slight tension on the ID chip cable as you slide the integrated subassembly into position, so that any slack in the cable will not become pinched between the subassembly and the rear housing.

3) Reinstall the three slide-lock covers on the back of the rear housing (see Fig. 3-14).

4) Route the ID chip cable connector through the rectangular slot at the bottom of the metal RFI shield (see Fig. 3-16), and plug the connector into the processor board.

5) Reassemble the monitor (see section 3.7).

3.9.2 Replacing a Fan

Fans are located in the upper left and right hand corners of the integrated subassembly. See Fig. 3-17. Each fan slides onto two plastic posts ① on diagonally opposite corners of the plastic mount, and secured in position by two plastic locking tabs ②. To replace a fan, three connector covers (Fig. 3-14) on the back of the rear housing must be removed to allow the integrated subassembly to be separated from the rear housing and the RFI shield removed from the Processor Board , but it is not necessary to completely remove the integrated subassembly from the housing or to further disassemble the subassembly.

3.9.2.1 Removing a Fan

1) Open the monitor following procedures of sections 3.5 and 3.6.

2) Remove and save the retaining screws that secure the metal RFI shield to the Processor Board Subassembly (see Fig. 3-18).

NOTE: Three different sizes and types of screws, as indicated by ①, ②, and ③ in Fig. 3-18, are used to secure the shield to the board. Note the type of screw in each location as you remove it, so that it can be reinstalled in the same location during reassembly.

3) Note the routing of the cable from the fan to be replaced, so that the replacement fan cable can be identically routed during reassembly, and unplug the cable connector from the Processor Board.

4) Follow procedure of secton 3.9.11 to separate the integrated subassembly from the rear housing just enough to access the fan to be replaced.

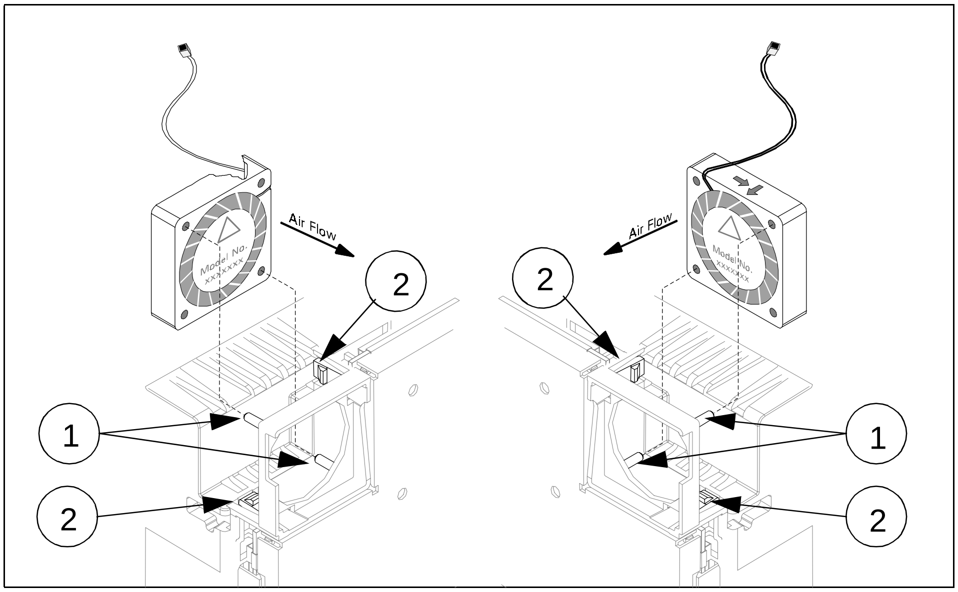

Fig. 3-17Fan Replacement

NOTE: There is enough length on the ID chip cable to permit a fan to be replaced without unplugging the cable connector and removing the integrated subassembly completely from the rear housing, but be careful to NOT place excessive strain on the cable.

5) Depress the tabs securing the fan to the plastic housing, as you slide the fan off of the mounting posts and remove it. Refer to Fig. 3-17.

3.9.2.2Installing a Fan

1) Slide fan onto the positioning posts, label side in as illustrated in Fig. 3-17, and route the fan cable as shown.

NOTE: Fan on left-hand side of the illustration has been rotated 90° so that the cable feeds across the inner side. The cable on the right-hand fan in the illustration lies across the top of the fan housing. This cable dress minimizes strain on the cables when they are plugged into the Main Processor Board.

2) Route the cable through the appropriate hole in the conductive cage, and plug it into the connector on the Main Processor Board.

3) Reposition the integrated subassembly in the rear housing so that the locking tabs snap into place in the top and bottom of the rear housing.

NOTE: Keep a slight tension on the ID chip cable as you slide the integrated subassembly into position, so that any slack in the cable will not become pinched between the subassembly and the rear housing.

4) Reinstall the three slide-lock covers on the back of the housing. See Fig. 3-14.
5) Reinstall the metal RFI shield on the Processor Board. See Fig. 3-18.
6) Reassemble the monitor (see section 3.7).
7) After completeing reassembly, power the monitor ON and assure that the replacement fan is exhausting air from inside the monitor.

3.9.3 Main Processor Board Subassembly

The Main Processor Board Subassembly is mounted in a conductive moulded plastic RFI cage that forms part of the integrated subassembly, with a metal RFI shield secured to the board on the access side of the cage. The board is positioned by its shape, and by channels cast into the sides of the IBP and IBP/Aux. connectors, that slide onto the sides of the access ports in the side of the cage. Also, a 48-pin connector located on the backside of the board, on the lower half near the center, plugs into the power conversion board. The subassembly is secured in the cage by five locking tabs (see Fig. 3-19).

3.9.3.1 Removing the Subassembly

1) With the integrated subassembly removed from the rear housing, unplug the two ribbon connectors from X5 and X6 on the Front End Board (see Fig. 3-21, ① and ②), that interface the Processor Board to the Front End Board .

   NOTE: The Front End Board Subassembly is on the back of the integrated subassembly.

2) Set the integrated subassembly back-side down on a clean flat surface
3) Remove and save the retaining screws that secure the metal RFI shield to the Processor Board Subassembly (see Fig. 3-18).

   NOTE: Three different sizes and types of screws, as indicated by ①, ②, and ③ in Fig. 3-18, are used to secure the shield to the board. Note the type of screw in each location as you remove it, so that it can be reinstalled in the same location during reassembly.

4) Unplug the 4-pin ID chip connector from the Processor Board, near the bottom of the rear housing (see Fig. 3-16), and feed the connector and cable back through the rectangular access hole in the RFI shield.
5) Lift the RFI shield out of the Rear Housing Subassembly and set it aside for reinstallation.

   NOTE: Be careful to NOT deform the finger strips forming an RF seal along the edges of the shield. Also, on some hardware revisions some of the RFI shield securing screws are into standoffs. If present, the standoffs must be unscrewed and removed before the processor board can be removed.

6) Unplug the two fan connectors at the top of the processor board.
7) With the cage oriented as shown in Fig. 3-19, lift up on the docking station connector as you press in the center tab at the connector, and then press in the tabs to the left and right of the center tab as you continue an upward pressure on the connector.

   NOTE: This unplugs the power supply connector, and also lifts the IBP and IBP/Aux. connectors out of the ports in the side of the cage.

8) Lift up on the right-hand side of the board as you release the tab lock at the top right, and then release the tab lock at the top left and lift the board out of the cage. See Fig. 3-19.

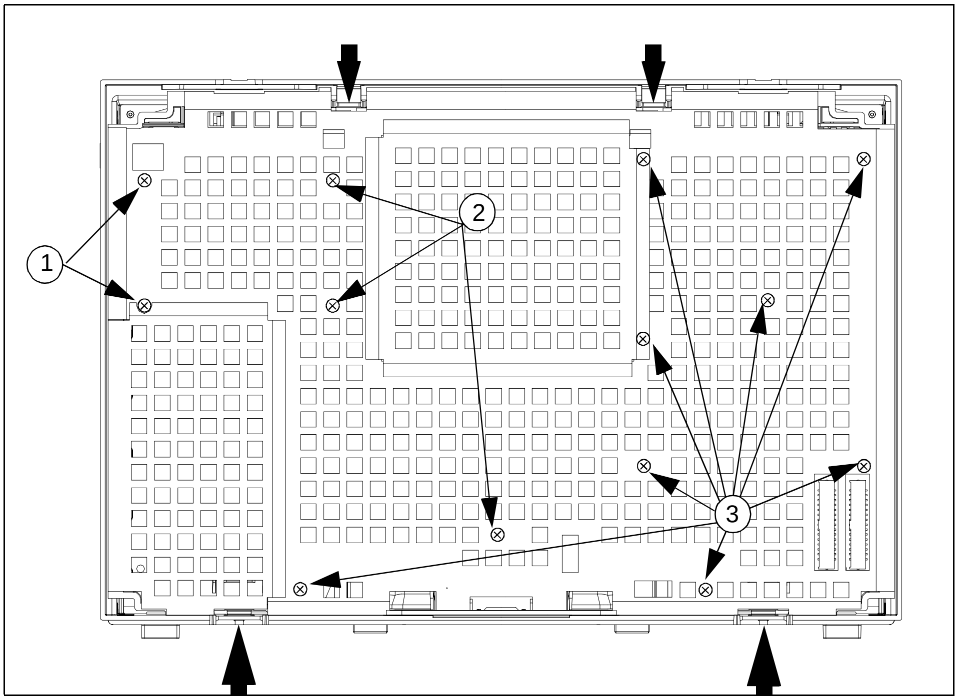

Fig. 3-18Location of Retaining Screws on Metal RFI Shield (①, ②, and ③): Heavy Arrows Indicate Location of Locking Tabs on Conductive Plastic RFI Cage Behind Metal RFI Shield

NOTE: The board is relatively heavy because of the heat sink on the bottom right-hand side. Also, be aware that the ribbon cable connectors tend to catch on the feed-through channel to the Front End Board, as you lift the Processor Board Subassembly out of the cage.

9) Place the subassembly on an anti-static mat or in an anti-static bag.

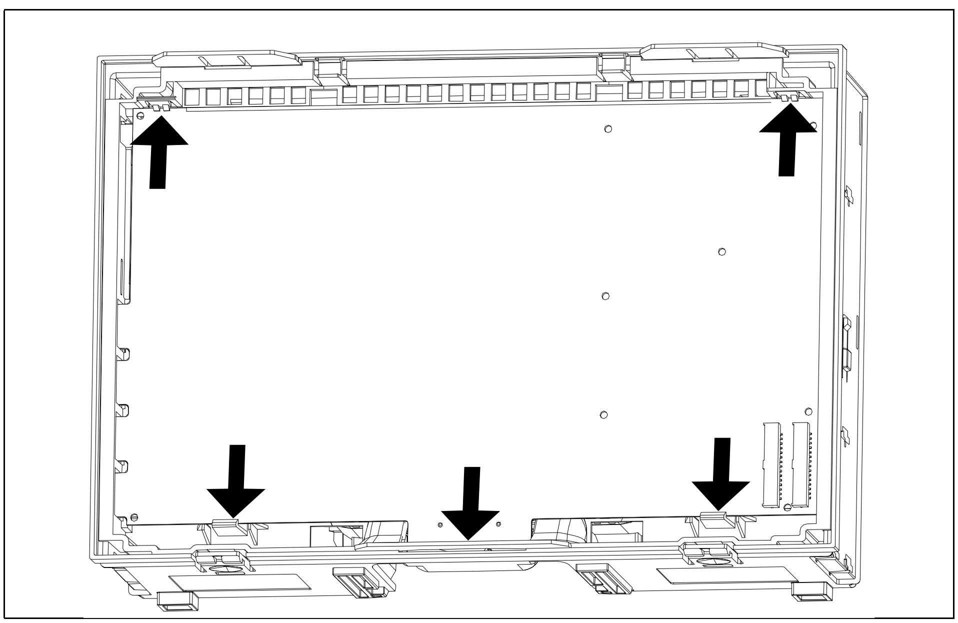

Fig. 3-19Location of Locking Tabs Securing Processor Board Subassembly

3.9.3.2 Installing the Subassembly

1) Position the Processor Board Subassembly so that the grey ribbon cables from the processor board to the front end board will drop through the slot in the RFI cage when the subassembly is seated.

2) Tilt the board slightly to tuck the edge of the PC board by the IBP and IBP/Aux. connectors under the lip of the cage and align the channels on the sides of the connectors with the sides of the access ports, and carefully seat the subassembly so that the board mounted connector on the bottom of the processor board seats properly into the connector on the Power Conversion Board Subassembly. Look down through hole in cage above power conversion board to be sure boards are mated properly.

3) Assure that all securing tabs are properly engaged.

4) Plug in the two fan cable connectors at the top of the processor board.

5) Plug the two gray ribbon cable connectors from the processor board into X5 and X6 on the front end board.

6) Route the ID chip cable through the slot by the power cable between the power conversion board and the front end board as illustrated in Fig. 3-19.

7) Seat the partially assembled RFI cage in the rear housing, and assure that the two tab locks in the top of the cage and the two in the bottom of the cage engage properly in the slots in the housing.

8) Using tweezers or a similar tool, if necessary, pull the ID chip cable to eliminate any slack.

9) Route the ID chip cable connector through the rectangular slot at the bottom of the metal RFI shield (see Fig. 3-16), and seat the shield on the Processor Board Subassembly.

10) Plug in the ID chip cable connector, and reinstall the securing screws in the metal RFI shield.

11) Reinstall the integrated subassembly into the rear housing (see section 3.9.1.2)

3.9.4 Power Conversion Board Subassembly

The Power Conversion Board Subassembly is located behind the Processor Board in the RFI cage. It is positioned by its shape and one positioning pedestal/post ①. Refer to Fig. 3-20. It is secured in position by a screw ② on the end of board-mounted connector X4, and by five locking tabs (see heavy arrows).

3.9.4.1 Removing the Subassembly

1) Remove the Processor Board Subassembly to access the Power Conversion Board Subassembly.

2) With the remainder of the integrated subassembly back-side down on a clean flat surface, unplug the power supply connector to the Front End Board from X1 (③ in Fig. 3-20) on the power conversion PC board.

3) Carefully feed the Ni-Cd battery connectors back through the square feed-through ports in the RFI cage, so that they will not snag on the ports when the board is removed.

4) Remove and save the Phillips-head screw at the bottom end of connector X4 (④ in Fig. 3-20). Keeping a slight upward pressure on the board, press in the tabs at the top and bottom of the right-hand side and the tab at the docking station connector cavity.

5) While lifting the board, press in the tabs at the bottom and top of the heat sink, and remove the board from the RFI cage.

6) Remove and save the heat sink and associated mounting hardware.

7) Place the board on an anti-static mat or in an anti-static bag...

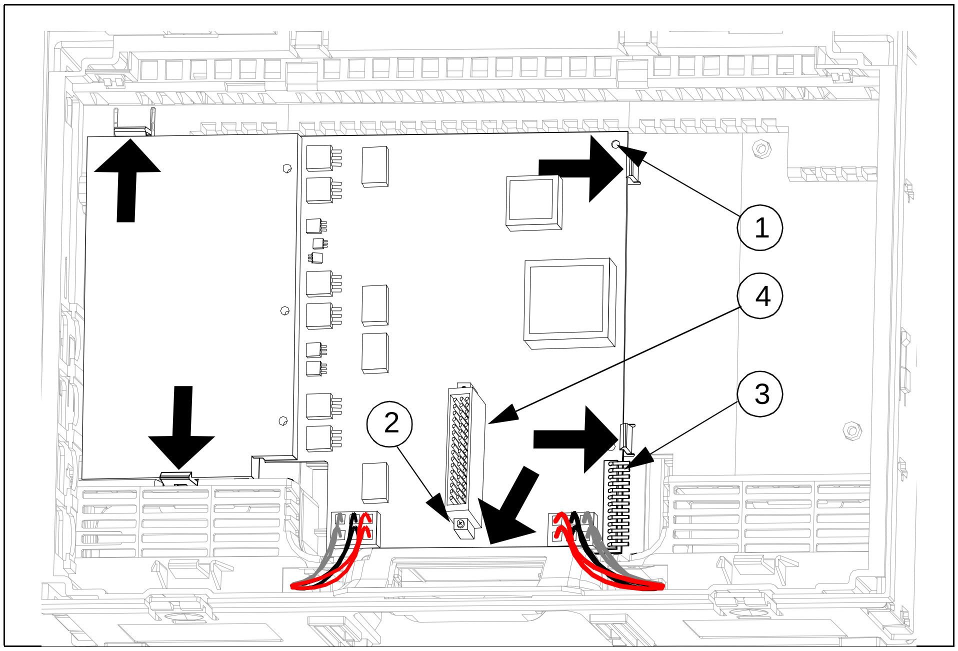

Fig. 3-20Location of Positioning Pedestal/Post ① and Locking Tabs Securing Power Conversion Board

3.9.4.2 Installing the Subassembly

1) With the RFI cage oriented as shown in Fig. 3-20, slide the heat sink of the Power Conversion Board Subassembly under the upper left-hand locking tab and against the left side of the cage.

   CAUTION: Use a long screw driver to push in grounding tab on bottom of board. Otherwise it will break.

2) Align the positioning pedestal/post with the mounting hole in the upper right-hand corner of the PC board, and carefully seat the subassembly to engage the four remaining locking tabs.

3) Install the securing screw in the mounting hole at the bottom of the board-mounted connector, X4.

4) Plug the front end board power cable into X1.

5) Route Ni-Cd battery cable connectors through the rectangular access ports in the cage.

6) Reinstall the Processor Board Subassembly (see section 3.7), and reassemble the monitor.

3.9.5 Front End Board Subassembly

It is necessary to remove the integrated subassembly from the rear housing, but it is not necessary to disassemble the integrated subassembly in order to access the Front End Board Subassembly. The Front End Board Subassembly is positioned by nine positioning pedestals/posts (five of which are visible through mounting holes in the front end PC board), and secured to the plastic chassis by seven locking tabs.

3.9.5.1 Removing the Subassembly

1) Remove the integrated subassembly from the rear housing, and place it face down on a clean flat surface (see Fig. 3-21).

2) Unplug the two gray ribbon cable connectors ① from X5 and X6, and the power supply cable connector ② from X3 on the Front End Board

3) Keeping a slight upward tension on the Front End Board Subassembly in the area of the MultiMed POD input connector ③, spread the two locking tabs located on each side of the connector housing to release the subassembly from the tabs.

4) Work your way counterclockwise around the subassembly to release each tab in succession until the subassembly is free.

5) Carefully lift the subassembly off of the positioning pedestals/posts, and set it on an anti-static mat or in an anti-static bag..

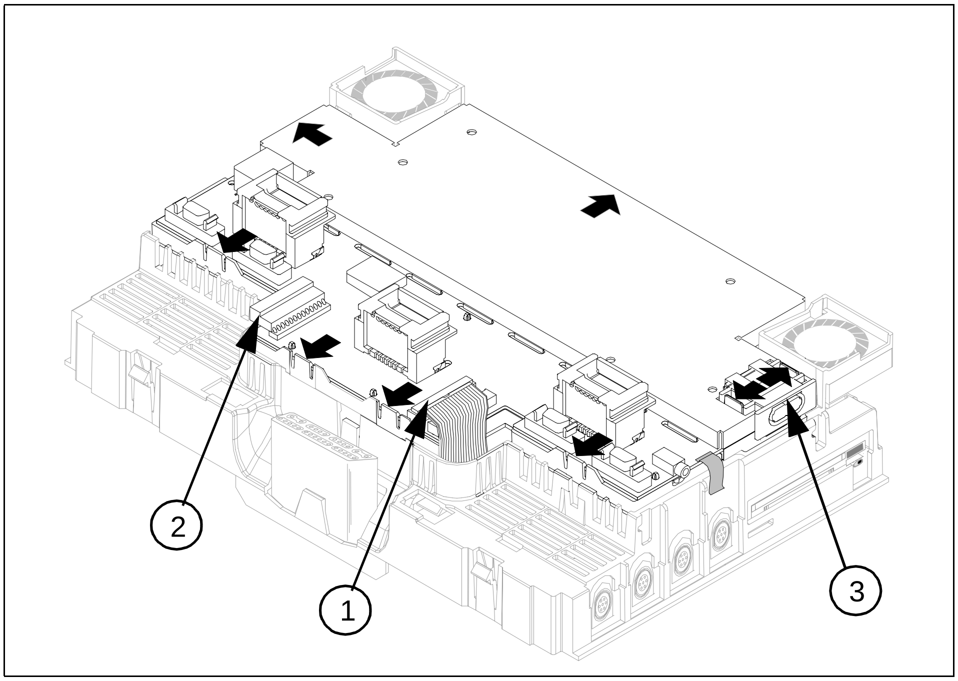

Fig. 3-21Front End Board - Location of Locking Tabs (indicated by heavy arrows), and Connectors

3.9.5.2Installing the Subassembly

1) Place the integrated subassembly RFI cage-side face down on a clean flat surface, oriented as shown in Fig. 3-21.

2) Position the Front End Board Subassembly so that the five positioning pedestals/posts are visible through the mounting holes in the PC board.

3) Press down to seat the subassembly and engage the locking tabs.

4) Assure that all locking tabs are properly set (refer to Fig. 3-21), and that the spring loaded grounding straps on each side of the board flex freely and are in contact with the conductive RFI cage.

5) Plug the two gray ribbon cable connectors ① and ② from the Processor Board into X5 and X6, and the power supply cable connector ③ from the Power Conversion Board into X3 on the Front End Board. Refer to Fig. 3-21.

6) Reinstall the integrated subassembly into the rear housing and reassemble the monitor (see section 3.7).

Chapter 4

Calibration/Adjustment and Functional Verification Field Procedures

4.1 Introduction

All calibration and adjustments required for proper operation of modules and PODS used in conjunction with an SC 9000 patient monitor base unit have been programmed into the software of the SC9000. Specific procedures needed in routine operations of the monitor are detailed in the Operating Instructions for the installed software version, and are required to be performed only when directed to do so by a message in the message field on the monitor display.

If a specific reading of a patient parameter is suspect, Siemens recommends a functional verification be performed for that function. Siemens recommends that a full functional verification for all patient parameters, including a leakage check, be performed on SC9000 monitors either annually or in accordance with local regulations. This chapter describes the functional verification procedures for SC 9000 Monitors in the field. The procedures verify proper operation of the monitor, using patient simulators and industry-standard test equipment, to verify that the monitor properly processes and reports patient physiological parameter signal inputs in conjunction with its associated Modules and PODs. Functional verification are “covers on” procedures.

Software and certain of the monitor’s hardware components are continually checked, first during power-up, and later during on-line self-tests. All operations are performing in accordance with design specifications if no error messages exhibit.

Perform all procedures with the main battery installed, and the monitor offline if mounted on a docking station and powered by a CPS. Disconnect all patient parameter signal inputs from the monitor, and plug in signal inputs only as instructed to do so. To assure that the monitor is off-line, do the following:

- With the *MAIN* screen displayed, press the Menu key and select the following:

  Monitor Setup → Biomed → Service
- In sequence, select 4, 7, 1, 2, and then Accept
- Assure that Network Control is set to OFF, and then press Main Screen key.

If the monitor fails to perform as indicated for any specific function during functional verification procedures, troubleshoot the monitor and POD and module associated with the function. Replace the defective subassembly, module, or POD, as appropriate, before completing functional verification.

4.2 Recommended Tools and Test Equipment

Use the specified recommended tools and test equipment, or a known equivalent, when performing functional verification tests. Substitutions are approved only if an equivalent is listed. Use of other test equipment and/or accessories could result in inconclusive tests or damage to system components.

Table 4-1 Recommended Tools and Test Equipment

Tools & Test Equipment			Description
ECG/Resp:			
Patient ECG/Resp simulator			Dynatech® 217A or equivalent
Leads:	Three-lead grabber set, or	IEC color code 1 IEC color code 2	Art. No. 33 75 230 E530U Art. No. 33 75 248 E530U
	Five-lead grabber set	IEC color code 1 IEC color code 2	Art. No. 33 75 255 E530U Art. No. 33 75 263 E530U
SpO_2:			
Patient SpO_2 simulator, or			Nellcor® PT2500 or equivalent
Reusable SpO_2 sensor:	Durasensor	Adult	Art. No. 45 34 475 EH50U
Non-Invasive Blood Pressure:			
NBP simulator (calibrated) or			Dynatech CuffLink®, or Veri-Cal® Pressure Transducer Tester, or equivalent
Mercury manometer with hand bulb			Baumanometer®, 0-300 mmHg
NBP Calibration Assembly			Art. No. 28 77 855 EE54U
NBP connection hose, 3.7 m			Art. No. 12 75 275 EH40U
$etCO_2$			
5.00 ±0.03% CO_2, balance N_2, Calibration Gas Cylinder			Art. No. 28 68 532 EE54U
Calibration Gas Regulator, with elbow fitting			Art. No. 28 68 540 EE54U
Mercury barometer with mm grade			
Invasive blood pressure:			
IBP simulator w/ test cable			Dynatech 217A or equivalent
Cardiac Output			
SHP ACC C.O. ADPT CBL SC9000			Art. No. xx xx xxx xxxxx
PolyMed Simulator, or equivalent			Art. No. 45 28 345 EH436
Temperature			
Temperature simulator w/ test cable (2 cables req'd)			Dynatech 217A or equivalent
SHP ACC TEMP ADPT CBL 1/4" JACK (2 req'd)			Art. No. 43 10 541 E530U
Leakage			
Leakage Tester			Bender µP-Safety Tester 601/751, or equivalent
Output Cables:			
Recorder ↔ Interface Plate / CPS			Art. No.47 21 770 E530U

4.3 Power Circuits and Startup

The following procedures check the monitor's power circuits, power-up sequence, and power off indicator. Begin this procedure with the monitor turned off and powered only by the main battery (with 100% charge level indicated by the LED bar graph on the top of the battery).

NOTE: If the monitor is mounted on a docking station, be sure that the locking lever is in the unlocked position.

4.3.1 Power ON/OFF

1) Press the ON/OFF switch on the front panel and verify that the power LED in the ON/OFF key turns on.
2) Press and hold the ON/OFF switch for approximately two seconds. Verify that a high pitched piezo tone sounds briefly and the power LED in the ON/OFF key turns off.

4.3.2 Power-Up Sequence

1) Press the ON/OFF switch and verify the following sequence of events:
   - The power LED in the ON/OFF key turns on.
   - The display illuminates briefly, the monitor beeps, a high-pitched piezo tone sounds briefly, and the Battery charger LED illuminates briefly.
   - After a few moments, during which the fans operate at high speed and the display is NOT illuminated, the monitor sounds a chime.
   - After a few more moments, the New Patient prompt displays on the *MAIN* screen.

     NOTE: "NBP Zeroing" appears briefly in the message area at the bottom left-hand side of the display, if the monitor is equipped with an NBP module.
   - Select NO, and press the rotary knob in to clear the prompt .

     NOTE: With all patient inputs removed from the monitor, only HR and the alarm status for the HR function appear in the HR parameter box field.
   - The battery charge level bar graph and the date and time are reported in the message area at the bottom right-hand side of the display.
2) Move the lever to the locked position, and verify that the Battery charger LED illuminates.
3) Remove the monitor from the docking station if functional verification procedures are to be performed using only main battery power.

4.4 Rotary Knob

The Rotary Knob in the lower right corner of the front panel controls an optical encoder for pointing to and selecting fields and functions on the display.

1) With the *MAIN* screen displayed, turn the knob one notch in either direction, and verify that the HR parameter box outlines.
2) Press the knob in to display the ECG menu.
3) Verify that the highlighted menu item changes for each detent as the knob is rotated one complete revolution in either direction.
4) After one complete revolution, highlight ¨ in the upper left-hand corner of the menu and press the rotary knob in.
5) Verify that the ECG menu clears and only the *MAIN* screen displays.

4.5 LCD Display

The display is composed of an active-matrix LCD screen with backlite. Test the LCD display as follows:

1) With *MAIN* Screen displayed, verify that there are ≤17 inoperative pixels ("stuck" ON).
2) Press the Menu key and select the following:

   Monitor Setup → Display Options
3) Select SC 9000 Brightness

4) Change the setting of the rotary knob and observe that the brightness of the display screen varies according to the % indicated..
5) Set the brightness for AUTO.
6) Verify that the backlite provides sufficient and consistent background illumination for the LCD.
7) Press Main Screen key to return to the *MAIN* screen.

4.6 Fixed Keys

The following tests verify that the switch membrane on the front panel is functioning properly, and that the signal from the key is processed by the Front Panel Control PCB. The functions controlled by the fixed keys are individually verified elsewhere in this Chapter.

4.6.1 ON/OFF Key

The ON/OFF key initiates the power-up sequence if the monitor is powered down, and powers-down the monitor, initiating a brief power-off piezo alarm, if the monitor is powered-up.

NOTE: This test can be omitted if the procedure of section 4.3.1 has already been performed.

1) Press and momentarily hold the ON/OFF key.
2) Verify that the powered state of the monitor changes from ON to OFF or from OFF to ON.

4.6.2 Main Screen Key

The Main Screen key sets the display to the *MAIN* screen.

1) Press the Menu key to display the Main menu.
2) Press the Main Screen key, and verify that the menu extinguishes, returning the display to the *MAIN* screen.

4.6.3 Alarm Silence Key

The Alarm Silence key silences an alarm tone for one minute.

1) Assure that the HR alarm is enabled, and without any input applied to the MultiMed POD, plug the MultiMed cable into the monitor.
2) Press the Alarm Silence key and verify that the alarm ceases.
3) Turn off the HR alarm in the Alarm Limits Table before proceeding.

4.6.4 Alarm Limits Key

The Alarm Limits fixed key calls up a setup table on which upper and lower alarm limits for physiologic parameters can be assigned, and alarms and alarm recordings can be enabled or disabled.

1) With the *MAIN* screen displayed, press the Alarm Limits fixed key.
2) Verify that the Alarms Setup Table displays.

4.6.5 All Alarms Off Key

The All Alarms Off key silences all alarms for a period of 3 minutes.

1) Press All Alarms Off key.
2) Verify that a 3 minute countdown field appears at the top center of the display.

4.6.6 Code Key

The Code key starts and stops an on-screen stopwatch.

1) Press the key and observe that a clock field appears in the bottom left-hand corner of the display.
2) Double-click the key to clear the clock field before proceeding.

4.6.7 Record Key

The Record key starts and stops a recording of limited duration.

1) Press the Record key.
2) Verify that the message “Recorder Not Connected” appears in the message field at the bottom right-hand side of the display.

4.6.8 Cont. Record Key

The Record key starts and stops a recording of unlimited duration.

1) Press the Record key.
2) Verify that the message “Recorder Not Connected” appears in the message field at the bottom right-hand side of the display.

4.6.9 NBP Start/Stop Key

The NBP Start/Stop key initiates or terminates the inflation cycle for the non-invasive blood pressure monitor function, and is inoperative if an NBP Module is not installed on the monitor.

1) Press the NBP Start/Stop key.
2) Verify that the monitor sounds a tone, or that “NBP Zeroing” or “NBP = 0 mmHg” appears in message field.

4.6.10 Zoom Key

When a patient is being monitored, the Zoom key calls up a 1-hour trend display for a quick overview of patient status. In the absence of patient input, to check that the membrane switch is functioning, press the key. Verify that the monitor sounds a tone.

4.6.11 Help Key

1) Press the Help key and observe that the Main Help Menu appears on the display.
2) Press Main Screen key to clear the display.

4.6.12 Mark Key

The Mark key inserts parameter values with time and date stamp in the tabular trends. Verify that the Mark membrane switch is functional as follows:

1) Press Menu key and select the following:

   Review → Trend Table

2) Press the Mark key and observe that the time stamp on the HR readout changes from white to green and the Mark symbol appears above the stamp.

4.7 ECG/RESP Functions

With the cable plugged into the monitor connect either a 3-lead or 5-lead ECG cable from the Patient Simulator into the MultiMed POD.

ECG/RESP Test Setup

1) Select the HR parameter box and press the rotary knob in to bring up the ECG menu.
2) Set all ECG Lead settings at default values and the remaining parameters as follows:
   - ARR Monitoring — Full
   - RESP Monitoring — ON
   - Pacer Detection — ON
   - QRS Sync Marker — ON
   - Pulse Tone Source — ECG
   - Pulse Tone Volume — 10%
3) Set the simulator as follows:
   - ECG = Normal Sinus
   - HR = 80 beats per minute (bpm)

- amplitude = 1.0 mV
- RESPIRATION = Normal Resp.
- rate = 20 breaths per minute (BPM)
- ohms = 1.0
- LEAD SELECT = II/RL-LL
- BASELINE IMPEDANCE = 500

4.7.1 Wave-forms/Digital Read-outs/Tones

1) Verify the following:
   - The waveform and digital heart rate correspond to the data provided by the simulator.
   - A heart symbol (♥) blinks and a pulse tone sounds for every detected QRS complex.
   - A white spike is present at each QRS complex.
   - The RESP and HR digital readout correspond to the settings of the simulator.
2) Vary the Tone Volume setting (between 1 and 10), and verify that the pulse tone volume changes accordingly.
3) Set the Tone Volume to OFF, and verify that the pulse tone stops.

4.7.2 Pacer Detection

1) Apply a paced signal from the simulator.
2) Verify that a small “P” accompanies the heart symbol (P♥) for every detected, paced beat, a blue spike appears for each paced signal, and the HR digital value agrees with the pacer bpm setting.
3) Generate an asystole condition in simulator, with pacer output still active.
4) Verify that ASY appears in the ARR parameter box, the box is red, an asystole alarm sounds, and the waveform is a flatline with pacer pulses.
5) Disable the pacer signal, and return the simulator to the setup above.

4.7.3 Lead-Off Indicators

1) One at a time, disconnect each of the ECG leads from the simulator.
2) Verify “Lead-Off” and “ECG Leads Invalid” messages appear in the message area at the bottom left-hand side of the display, the pulse tone ceases, and *** replaces the digital heart rate in the HR field.
3) Reconnect all leads to the simulator.

4.7.4 Alarm Function

This procedure also tests that the alarm function of the monitor, as applicable to all other patient parameters, is operational in the monitor.

1) In the Alarm Limits Table, set the HR alarm parameters as follows:
   - Upper limit = 110 bpm
   - Lower limit = 40 bpm
   - Alarm = ON
2) Set the simulator to HR = 120 bpm.
3) Verify that the monitor responds with the following Serious Alarm indications:
   - HR in the parameter field = 120
   - The HR parameter field blinks with a yellow background.

- A Serious Alarm tone sounds.
- The message HR > 110 on a yellow background appears in the message area at the bottom left-hand side of the display.

4) Reset the simulator to HR = 80 bpm.
5) Verify the following:
   - HR parameter field returns to normal color
   - HR returns to 80
   - The message area continues to report the cause of the most recent alarm, HR > 110, on a yellow background.
6) Press the Alarm Silence fixed key.
7) Verify that the “HR > 110, on a yellow background” ceases to be reported.

4.7.5 Asystole

Switch power to the simulator OFF. Verify that the HR parameter field reports ASY, “Asystole” appears in the message area at the bottom left-hand side of the display, and the monitor responds with a Life-Threatening alarm.

4.8 SpO_2 Function

The SC9000 monitors oxygen saturation (SpO_2) and pulse rate using the spectrophotometric method. SpO_2 software is checked on monitor power-up and also periodically while the monitor is in operation.

SpO_2 Test Setup

The SpO_2 parameter box appears when an SpO_2 input is applied to the monitor through the MultiMed POD.

1) Select the SpO_2 parameter box to access the menu. Set the parameters as follows:
   - Pulse Tone Source - SpO_2
   - Pulse Tone Volume -10%
   - Waveform Size - 10%
   - Averaging - Normal
2)
   - If using a variable SpO_2 simulator, set the SpO_2 level to 98% and the pulse rate to 70 bpm, and plug the simulator into the SpO_2 input adapter cable to the MultiMed POD.
   - If using a Nellcor PT-2500 pocket tester or equivalent, plug the tester into the SpO_2 input adapter cable to the MultiMed POD.

4.8.1 Waveforms/ Digital Read-outs/ Tones

1) Verify the following:
   - A simulated SpO_2 waveform appears, and the digital SpO_2 and pulse rate (PLS) values correspond to the simulator settings.
   - The ♥ symbol blinks in the SpO_2 field, and a pulse tone sounds in synchrony with the appearance of the ♥ symbol.

4.8.2 Pulse Tone Generator

1) Select Pulse Tone Volume in the SpO_2 menu. Vary the volume setting and verify that the pulse tone volume changes accordingly.
2) Set Pulse Tone Volume to OFF, and verify that the tone stops.
3)
   - If using a variable simulator change the oxygen saturation value, and verify that the pulse tone frequency (pitch) increases as the SpO_2 level increases, and decreases as the SpO_2 level decreases.

- If using the pocket tester or equivalent, replace the tester with an adult finger sensor and place the sensor on your finger. Your SpO2 reading should be > the reading obtained from the testor, and the frequency (pitch) of the pulse tone should increase.

4.9 Temperature Function

4.9.1 Temperature Test Setup

Set up the patient simulator to supply a temperature input to the MultiMed POD connector through the Temperature Test Adapter Cable.

Set the simulator for a standard 37°C.

4.9.2 Digital Readout

1) Verify that the monitor indicates a temperature of 37±0.1°C.
2) Change the simulator to a temperature above and then below the 37°C.
3) Verify that the monitor readout agrees with the simulator settings ±0.1°C.

4.10 Non-Invasive Blood Pressure Function

The SC 9000 measures non-invasive blood pressure (NBP) according to the oscillometric method. You can start a manual measurement using the NBP Start/Stop fixed key, or set the monitor to take automatic NBP measurements at selected intervals.

4.10.1 Test Setup

1) Set up the monitor and NBP Calibration Assembly (Art. No. 28 77 855 EE54U), as illustrated in Fig. 4-1.

   NOTE: A pressure indicator such as the VERI-CAL™ Pressure Transducer Tester can be used in place of the manometer.
2) Select the NBP parameter box and press the rotary knob in.
3) Set the following in the NBP parameter field menu:
   - Interval Time - OFF
   - Continuous Mode - OFF
   - Calibrate Mode - ON.

     NOTE: Observe that “NBP Cal. = 0 mmHg” message appears in the message field at the bottom right-hand side of the display.
4) Press Main Screen key or select ¨ at the top of the NBP field menu to return to the Main menu..

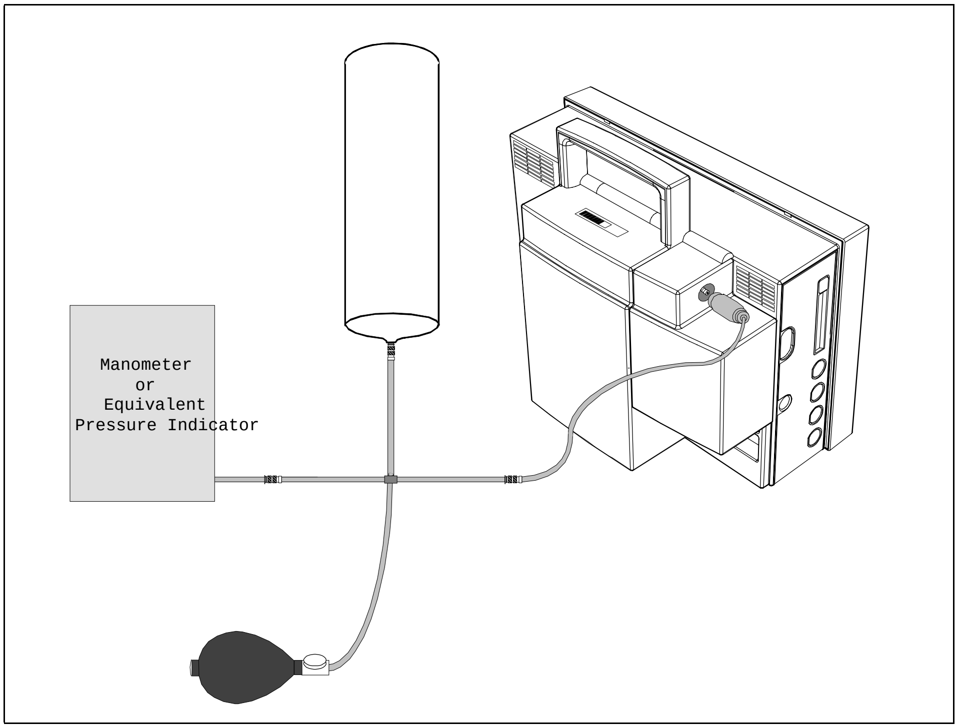

Fig. 4-1 NBP Calibration Test Setup

5) Using the hand bulb, increase the pressure to 250 ±5 mmHg, and allow it to stabilize for 1 minute.

6) At the manometer or equivalent pressure indicator, observe the pressure drop for an additional minute. Verify that the pressure drop is <8 mmHg in 1 minute.

4.10.2 Calibration Check

1) Using the hand bulb, increase the pressure to 250 mmHg.

2) Verify that the pressure values displayed on the monitor and manometer are within ±3 mmHg of each other.

3) Slowly release the pressure in 50 mmHg increments. At static pressures of 200, 150, and 100 mmHg, verify that the cuff pressure values displayed on the monitor and manometer are within ±3 mmHg of each other at each level.

4.10.3 Hardware Overpressure

4) While the monitor is still in calibration mode, slowly increase the pressure. Observe the pressure rise on the monitor’s screen.

5) Verify that the pressure suddenly drops at 300 ±3 mmHg.

6) Release the pressure before proceeding.

4.10.4 Pump

1) Set Calibrate Mode in the NBP parameter field menu to OFF.

2) Press NBP Start/Stop key.

3) Verify the following:
   - The pressure increases and then decreases.
   - Inflation and deflation pressures reported in the message field.
   - The message “NBP No Pulsation” exhibits at the conclusion of the deflation phase.
   - All digital readouts in the NBP field are ***.

4.10.5 Interval Mode

1) With the NBP Calibrate Mode set to OFF, set the Interval Time to 1 min.
2) Verify the following:
   - A one-minute countdown bar graph appears at the bottom of the NBP parameter box.
   - The NBP pump starts immediately when the rotary switch is pressed in.
   - The NBP sequences through an inflation/deflation cycle and produces an "NBP No Pulsation" message in the message field at the bottom left-hand side of the display
   - The NBP pump starts again when the one-minute countdown bar resets to initiate another cycle.
3) Press the NBP Start/Stop key to stop the cycle, and reset the Interval Time to OFF.

4.10.6 Safety Timer

1) Assure that NBP Calibrate Mode is set to OFF.
2) Press the NBP Start/Stop fixed key to start the pump.
3) Press the same key again to stop the measurement.
4) Set NBP Calibrate Mode to ON, and press the Main Screen key.
5) Press the Code key to start the screen stopwatch. Observe the monitor's screen. Press the Code key again to stop the watch when the "NBP Cuff Deflation Error" message displays, indicating that the safety timer has been activated.
6) Verify that the elapsed time is 120 - 180 seconds.
7) Press the NBP Start/Stop fixed key.
8) Verify that a tone sounds and the pump fails to start.
9) Power-cycle the monitor to clear the fault condition.

4.11 etCO_2 Function

The etCO_2 Module enables the SC9000 to non-invasively monitor end-tidal CO_2 using a technique that relies on the selective absorption properties of the CO_2 to specific frequencies of infra-red radiation. The etCO_2 module automatically compensates for variations in the ambient barometric pressure if set to automatic mode. Before beginning this procedure, use a mercury column barometer or equivalent other device to determine the local atmospheric pressure. Record this value.

1) Plug accessory assembly into module.
2) Note that the parameter box appears on the monitor display screen, and that "etCO2 Sensor Warming Up" followed by "etCO2 Place Sensor on Zero Cell" appears in the message field.
3) While sensor is warming up, select the etCO2 parameter box and assure that Atmospheric Pressure is set to "Manual," and is set to the value indicated by the mercury column barometer.
4) Place sensor on Zero Cell.
5) Note that "etCO2 Calibrating Sensor" appears in the message field, followed by "etCO2 Place Sensor on Ref Cell."
6) Place sensor on Reference Cell.

7) Verify that "etCO2 Verifying Sensor Cal" followed by "etCO2 Sensor Cal Verified" appears in the message area, and the reading in the etCO2 parameter box = 38 ±2mmHg.

8) Attach the adult airway adapter to the calibration gas cylinder. Do NOT open the valve on the cylinder.

   NOTE: As CO_2 is heavier than room air, set up the airway adapter such that the point where the gas exits from the adapter is higher in elevation than the point where it enters.

9) Place the sensor on the adult airway adapter and note the reading = 0 ±1 mmHg.

10) Turn the valve on the cylinder until it is fully open.

11) Wait for 30 seconds and record the displayed value.

12) Close the valve and remove the sensor from the airway.

13) Verify that the measured value is in the range (0.05 x local pressure) ±3, rounded to the nearest integer.

14) Select the etCO2 parameter box and set Atmospheric Pressure to AUTO.

15) Repeat steps 4 through 12.

16) Verify that the measured value = the previously measured value ±3, rounded to the nearest integer.

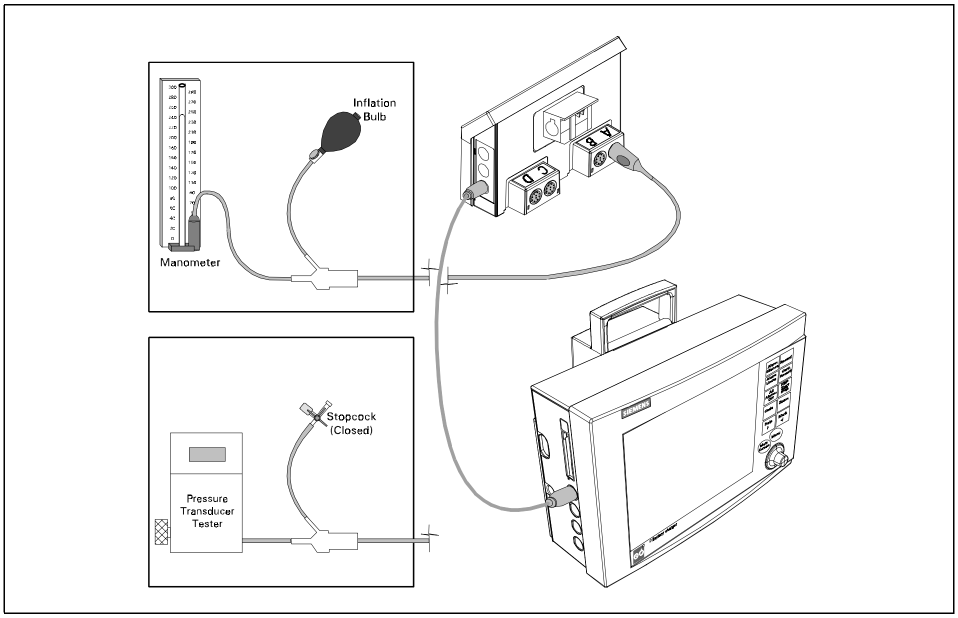

Fig. 4-2 IBP Functional Verification Test Setup

4.12 HEMO POD / Invasive Blood Pressure Function

IBP parameter boxes for up to two pressures for a HEMO 2 POD or up to four pressures for a HEMO 4 POD display automatically when the IBP signal from the HEMO POD is plugged into the monitor, if the Display Mode has been set to automatic.

If performing a functional verification only on the SC9000 base unit do steps 1 through 20 in this section, and then go on to Section 4.13. If also functionally verifying all functions of the HEMO POD do all steps in this section before proceeding to Section 4.13.

4.12.1 IBP Test setup:

1) With the MultiMed cable and all other patient inputs unplugged from the monitor, power-cycle the monitor. Select NO in the New Patient prompt to clear the display.

2) With the *MAIN* screen displayed, connect the BP output from the simulator to the first input, channel A, on the HEMO POD adapter.

3) Plug the cable from the IBP SC9000 output from the HEMO POD into IBP input 1on the monitor.

4) Note that parameter box with same pressure label as is shown in the LED window for channel A on the front of the HEMO POD appears on the display.

5) Set the IBP simulator for a static pressure = 0 mmHg.

6) Note that a “Zero Required” message, identified by the same pressure label as observed in step 4, appears in the message field.

7) Press Zero All key on the HEMO POD.

4.12.2 Monitor Zero Function

8) Verify that a “Zero Accepted” message that changes to “Static Pressure,” both identified by the same pressure label, appear in the message field.

9) Assure that Cal Factor and Manometer Cal are set to 100.

10) Select a pulsatile pressure on the patient simulator.

4.12.3 HEMO POD Channel A; Monitor IBP1

11) Verify that the pressure reading on the monitor is in agreement with the values generated by the pressure signal from the simulator.

12) Unplug the HEMO POD output cable from IBP input 1 on the monitor and plug it into IBP input 2.

13) Observe that the label on the pressure parameter field changes to agree with the pressure label on channel A of the HEMO POD.

4.12.4 Monitor Input IBP2

14) Repeat steps 10 and 11 for IBP input 2.

15) Unplug the HEMO POD output cable from IBP input 2 on the monitor and plug it into IBP/AUX. input 3.

16) Observe that the label on the pressure parameter field changes to agree with the pressure label on channel A of the HEMO 2/4 POD.

4.12.5 Monitor Input IBP3

17) Repeat steps 10 and 11 for the IBP/AUX. input 3.

4.12.6 Monitor Input IBP4

18) Unplug the HEMO POD output cable from IBP/AUX. input 3 on the monitor and plug it into AUX. input 4.

19) Verify that the monitor sounds a double chime and the message “Hemo On Connector 4 Invalid” appears in the message field.

20) Unplug the HEMO POD output cable from the AUX.input 4, and plug it into IBP input 1.

If functionally verifying only the SC9000 base unit, omit the remaining steps in this section and go to Section 4.13. If also functionally verifying the HEMO POD, go on to step 21.

21) Unplug the BP adapter cable from channel A on the HEMO POD and plug it into the second input, channel B.

4.12.7 HEMO2 POD Channel B

22) Repeat steps steps 10 and 11 for channel B.

23) If the HEMO POD has four channels, unplug the BP adapter cable from channel B and plug it into channel C.

4.12.8 HEMO2 POD Channel C

24) Repeat steps 10 and 11 for channel C.

25) Unplug the BP adapter cable from channel C and plug it into channel D.

4.12.9 HEMO2 POD Channel D

26) Repeat steps 10 and 11 for channel D.

27) Unplug the simulator input adapter cable from the HEMO POD.

4.13 HEMO POD Temperature Function

1) Plug the fixed temperature (37°C) output from the simulator into the TEMP A connector on the side of the HEMO POD.

2) Plug the selectable temperature output from the simulator into the TEMP B connector on the side of the HEMO POD, and set the temperature for a value other than 37°C.

4.13.1 Monitor Input IBP 1

3) Plug the IBP SC9000 output from the HEMO POD into the IBP input 1 on the SC9000.

4) Verify the following:
   - a T field appears on the MAIN screen
   - the T1a temperature = 37 ±0.1°C
   - the T1b temperature = simulator setting±0.1°C.

5) Select Temperature field, and press rotary knob in to access TEMP1 menu.

6) Select TEMP Display and then select $\Delta T1$.

7) Verify that T1b changes to $\Delta T1$ and reports the temperature difference between T1a and T1b.

8) Reset the TEMP Display in the TEMP1 menu to T1b.

9) Press Main Screen key to clear the table.

4.13.2 Monitor Inputs IBP 2, IBP 3

10) Repeat steps 3 through 9 for the HEMO POD output cable plugged into IBP input 2 (for T2 function verification) and then IBP/Aux. input 3 (for T3 function verification).

11) Return to the *MAIN* Screen.

4.14 Cardiac Output Function

1) Plug the C.O. output from the simulator into the C.O. test adapter cable, and plug the adapter cable into the C.O./Temp B input on the HEMO POD.

2) When READY appears in the CO parameter field verify that the blood temperature indication is 37 ±0.15°C.

3) Press C.O. START key on the simulator, and verify an Injectate Temperature indication of 1 ±0.2°C.

4.15 Memory Backup Function

The monitor retains patient-related data, such as alarm limits, trends, and stored alarm recordings when it is powered off.

1) With the monitor powered-up and no patient inputs applied, press the Alarms Limits fixed key and change the limit for any parameter.

2) Power monitor off for approximately 1 minute, and then power it back on.

3) After *MAIN* screen displays, press Alarm Limits fixed key to call up Alarm Limits Table.

4) Verify that the new limit(s) you set in Step 1 have been retained.

4.16 Network Function

This procedure tests that the SC9000 communicates with a CPS.

1) Mount the monitor on a docking station connected to a CPS.
2) Press Menu key and select Monitor Setup → Biomed → Logs.
3) Select Component Log → CPS.
4) Verify that the Serial # of the CPS appears on the display.

4.17 Recorder Function

The R50 Recorder connects to the SC9000 monitor through the CPS or through an interface plate. The following procedure verifies that the monitor is communicating with the Recorder.

1) Connect a known good R50 Recorder to the monitor, either through a CPS or via an interface plate.
2) Press the Record fixed key.
3) Verify that the recorder begins to dispense blank paper.
4) Press Stop key on recorder to stop paper flow.

4.18 Leakage Current Tests

The SC9000 monitor is a battery operated device, grounded through the CPS power supply when operated from a docking station. The leakage current tests assure that under both normal and fault conditions, any leakage current does not exceed the values given in Table 4-2.

1) Perform leakage current tests with the SC9000 monitor on a docking station and with the CPS plugged into the leakage tester. See Figure 4-3.

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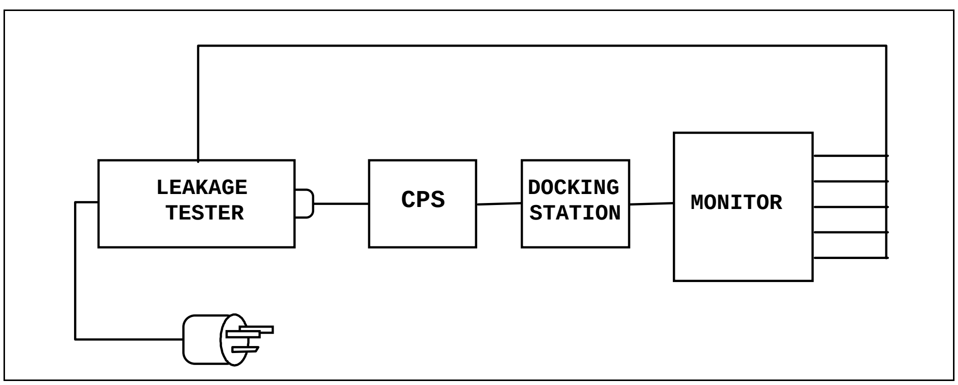

Fig. 4-3 Block Diagram: Earth Leakage Current

2) Follow the leakage tester manufacturer’s instructions to measure each of the leakage currents given in the Table, for each of the following conditions:
   - open ground
   - reversed polarity
   - open ground reversed polarity

Table 4-2 Leakage Current Tests

TEST	Max. Current
Chassis to Ground	<100 µA
Combined Lead Leakage	<10µA*
Individual Lead Leakage	<10µA*
Paired Lead Leakage	<10µA*
Leakage with Line Voltage on Leads	<10µA*
*Add an additional 10µA if the measurements are taken at the patient end of patient lead cables.	

3) Verify that the current does not exceed the values given in Table 4-2.

4) Record all values in the monitor's functional verification checklist.

4.19 Battery Charger Circuit

1) With a partially discharged main battery installed on the monitor, place the monitor on a powered docking station and bring up the *MAIN* screen.

2) Press Menu key, and select Review Æ Battery on the Main menu.

3) Note that the report indicates that the monitor is powered by the CPS, and note the charge levels in the Internal and External Batteries.

4) After 1 hr., recheck the charge levels on the Internal and External Batteries.

5) Verify that the charge level on the External (or Internal) Battery has increased.

NOTE: If the Internal battery charge level is initially <100%, charging of the main external battery will not begin until the internal battery has reached full charge.

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Chapter 5

Troubleshooting

5.1 Introduction

Troubleshooting SC9000 monitoring systems is either a two- or three-step process.

1. Determine whether the trouble is external, such as a malfunctioning module, POD, connector, or cable, or internal to the monitor.
2. • If external, replace malfunctioning item and then functionally verify proper operation of item before returning monitor to clinical service.
   • If internal, go on to step 3.
3. Possible remedial actions include recalibration, such as in the case of an NBP module, $etCO_2$ module, or a HEMO POD, and replacement of the malfunctioning system component or subassembly. Refer to Appendix A for a complete listing of replaceable system components and subassemblies.
   • After calibrating a module, functionally verify proper operation of recalibrated module before returning monitor to clinical service.
   • After replacing an internal subassembly, functionally verify all monitor functions before returning monitor to clinical service.

SC 9000 monitoring system devices consist of the SC 9000 Base Unit, and peripheral devices including Docking Station, Auxiliary Docking Station, CPS, R50 Recorder, $etCO_2$ Module, NBP Module, MultiMed POD, HEMO POD, and Remote Display.

5.1 Recommended Tools and Test Equipment

Use specified, recommended tools and test equipment, or a known equivalent, when troubleshooting SC 9000 monitors and peripheral equipment. Substitutions are approved only if an equivalent is listed. Use of other test equipment and/or accessories could result in inconclusive tests or damage to system components.

Table 5-1 Recommended Tools and Test Equipment

Tools & Test Equipment			Description
Digital Multimeter (DMM), 4.5 digit			Fluke, model 8050A (or equiv.)
Patient ECG/RESP, Temp, IBP simulator			Dynatech® 217A or equivalent
Leads:	Three-lead grabber set, or	IEC color code 1 IEC color code 2	Art. No. 33 75 230 E530U Art. No. 33 75 248 E530U
	Five-lead grabber set	IEC color code 1 IEC color code 2	Art. No. 33 75 255 E530U Art. No. 33 75 263 E530U
Patient SpO_2 simulator, or			Nellcor® PT2500 or equivalent
Reusable SpO_2 sensor:	Durasensor, Adult		Art. No. 45 34 475 EH50U
NBP simulator (calibrated) or Mercury manometer with hand bulb, or Electronic pressure indicator with handbulb			Dynatech CuffLink® Baumanometer®, 0-300 mmHg Veri-Cal® Pressure Transducer Tester, or equivalent
NBP Calibration Assembly			Art. No. 28 77 855 EE54U
NBP connection hose	3.7 m		Art. No. 12 75 275 EH40U

5.2 Hardware-Based Power Problems

5.2.1 No Response When Power ON/OFF Key Pressed

There are several possible reasons why a monitor might not respond when the Power ON/OFF key is pressed. Because the monitor can be powered-on when being powered by any of several different sources, the troubleshooting procedure required depends on the conditions that exist with regard to the various power sources when Power ON/OFF key is pressed. Refer to Table 5-2.

Table 5-2Power-on Problems

Conditions	Possible Cause(s)	Troubleshooting and Remedial Action
Monitor not on docking station; external battery module installed	External Battery Module discharged or needs to be replaced Power Conversion Board malfunction Front Membrane Switch or Panel Board malfunction	Check charge level bar graph on top of battery module. If charge level indication = 0%, replace battery with a fully charged battery module before proceeding to step 1. 1. Place monitor on a powered docking station. 2. When Battery charger LED illuminates, press Power On key to power monitor ON and access *MAIN* screen. • If Battery charger LED fails to illuminate, refer to Condition - "Monitor on docking station; Battery charger LED not illuminated." • If power ON LED fails to illuminate, replace Front Panel Subassembly. If problem persists, with monitor on Docking Station, return monitor to Siemens for repair or exchange. 3. Press Help key, and select Getting Started → Battery to access the Battery Status report. 4. Assure that indicated power source on report is CPS. NOTE: If the CPS is used to recharge the External Battery Module, recharging will begin only after the charge level on the internal battery has reached ≈99%. This requires ≈4 hrs with initially fully discharged internal batteries. The External Battery Module then requires 8 more hours to fully charge. 5. Return to *MAIN* screen and press Code key to initiate the stopwatch. 6. After several minutes, reaccess the Battery Status report. 7. Assure that the Battery Charge Level on the Internal Batteries has increased several percent. NOTE: If charge level fails to increase replace the Power Conversion Board Subassembly. If problem persists, return monitor to Siemens for repair or exchange." 8. If external battery fails to recharge 100% in 8 hours after the charging process began, replace External Battery Module. 9. If problem persists, replace Power Conversion Board Subassembly. If problem persists, return monitor to Siemens for repair or exchange.

Conditions	Possible Cause(s)	Troubleshooting and Remedial Action
Monitor not on docking station; external battery module not installed	Internal Ni-Cd Batteries discharged or need replacing Power Conversion Board malfunction Front Panel Membrane Switch or Panel Board malfunction	1. Place monitor on powered docking station. 2. When Battery charger LED illuminates, press Power On key to power monitor ON and access *MAIN* screen. • If Battery charger LED fails to illuminate, refer to section on Condition - "Monitor on docking station; Battery charger LED not illuminated." • If power ON LED fails to illuminate, replace Front Panel Subassembly. If problem persists, with monitor on Docking Station, return monitor to Siemens for repair or exchange. 3. Press Help key, and access Getting Started → Battery. 4. Note that the indicated power source on the Battery Status report is CPS, and the battery charge levels. 5. Return to *MAIN* screen and press Code key to initiate the stopwatch. 6. After several minutes, reaccess Battery Status report. 7. Assure that the Battery Charge Level on the Internal Battery has increased several percent. • If battery charge level has increased, leave monitor on docking station for ≥ 4 hrs to recharge the internal Ni-Cd batteries. • If battery charge level has NOT increased, try replacing Ni-Cd batteries, and repeat steps 6 and 7. If charge level remains constant, go to step 9. 8. After charging Ni-Cd batteries for >4 hrs, recheck battery charge level on Battery Status report. • If charge level = 100%, return monitor to clinical service. • If charge level <100% replace Ni-Cd batteries. 9. If problem persists with new Ni-Cd batteries, replace Power Conversion Board Subassembly. 10. If problem persists, return monitor to Siemens for repair or exchange.

Conditions	Possible Cause(s)	Troubleshooting and Remedial Action
Monitor on docking station; Battery charger LED not illuminated	CPS malfunction Docking Station / cable malfunction Power Conversion Board malfunction Front Panel Subassembly malfunction	1. Assure that CPS is connected to an active hospital power source and is switched ON. NOTE: If CPS power switch LED is not illuminated, check power source and power cable. If both O.K., return CPS to Siemens for repair or exchange. 2. Measure voltage between pins 11 and 12 at the connector on the docking station. 3. If voltage = 12±2 VDC, continue to step 4. If voltage ≠ 12±2 VDC, measure voltage between pins 11 and 12 at the docking station cable connector on the CPS. • If voltage O.K., return Docking Station and cable to Siemens for repair or exchange. • If voltage not O.K., return CPS to Siemens for repair or exchange. 4. Replace Power Conversion Board Subassembly. 5. If problem persists, replace Front Panel Subassembly. 6. If problem persists, return monitor to Siemens for repair or exchange.
Monitor on docking station; Battery charger LED illuminated	Front Panel Board malfunction Membrane Switch malfunction Main Processor Board malfunction	1. Press Power On key to power monitor ON and access *MAIN* screen. 2. If power ON LED fails to illuminate, replace Front Panel Subassembly. 3. If problem persists, replace Main Processor Board Subassembly. 4. If problem persists, return monitor to Siemens for repair or exchange.

5.3 Fixed Key Fails to Function.

Table 5-3Fixed Key Malfunction

Conditions	Possible Cause(s)	Troubleshooting and Remedial Action
A Fixed Key fails to perform as described in Fixed Key functional verification procedures in Chapter 5.	Membrane switch malfunction Front Panel Board malfunction Main Processor Board malfunction	1. Replace Front Panel Subassembly. 2. If problem persists, replace Main Processor Board Subassembly. 3. If problem persists, return monitor to Siemens for repair or exchange.

5.4 Power-Off Piezo Alarm Fails to Sound.

Table 5-4Power-off Alarm Malfunction

Conditions	Possible Cause(s)	Troubleshooting and Remedial Action
Monitor powers-up normally, but monitor piezo alarm fails to sound if monitor loses power or when monitor is powered-off.	Speaker malfunction Front Panel Board malfunction Piezo circuit on Power Conversion Board malfunction Main Processor Board malfunction	1. Replace speaker on Front Panel Subassembly. 2. If problem persists, replace Front Panel Subassembly 3. If problem persists, replace Power Conversion Board Subassembly, 4. If problem persists, replace Main Processor Board Subassembly. 5. If problem persists, return monitor to Siemens for repair or exchange.

5.5 Power-Up Sequence Fails to Complete Properly

Table 5-5Power-up Process Malfunction

Conditions	Possible Cause(s)	Troubleshooting and Remedial Action
Power inputs all OK but monitor fails to complete the power-up sequence, e.g., sounds continuous tone or powers itself down before *MAIN* screen displays, sounds two tones and then a continuous tone, continually resets after initial power-up.	Internal ribbon cable connection malfunction Software version ≤ VA1.1 installed Software program corrupted Main Processor Board malfunction	1. If power ON LED illuminates but monitor fails to complete power-up sequence, check the following: • If continuous tone sounds when monitor powered-up immediately following software download using boot procedure, check that the boot switch has been set to OFF (up position). • If the problem has occurred immediately following reassembly of the monitor, reopen the monitor and assure proper connection of all ribbon cables. • If monitor has been functioning properly and problem occurred spontaneously, software may have become corrupted. Try reinstalling the software. 2. If installed software version <VA1.1, upgrade software to version ≥ VA1.1. 3. If problem persists, boot monitor from PCMCIA card containing software version ≥ VA1.1. 4. • If power-up sequence fails to complete properly when monitor booted from PCMCIA card, replace Main Processor Board Subassembly. • If power-up sequence completes properly, finish installing software program and return monitor to clinical service. 5. If problem persists, return monitor to Siemens for repair or exchange.

5.6 Rotary Knob Malfunction

The rotary knob in the lower right corner of the front panel controls an optical encoder for pointing to and selecting fields and functions on the display. Refer to Table 5-6.

Table 5-6Rotary Knob Malfunction

Conditions	Possible Cause(s)	Troubleshooting and Remedial Action
Rotary knob fails to properly select fields, or pressing the knob in fails to activate a menu or select a default.	Optical Encoder Subassembly malfunction Front Panel Board malfunction Main Processor Board malfunction	1. Replace Optical Encoder Subassembly 2. If problem persists, replace Front Panel Board Subassembly. 3. If problem persists, replace Main Processor Board Subassembly. 4. If problem persists, return monitor to Siemens for repair or exchange.

5.7 LCD Display Malfunction

The display subassembly is composed of an active-matrix LCD screen with fluorescent backlite. See Table 5-7.

Table 5-7LCD Display Malfunction

Conditions	Possible Cause(s)	Troubleshooting and Remedial Action
Screen brightness remains unchanged when the Transport Brightness setting in the Service menu is changed.	Monitor is being powered by CPS Front Panel Board malfunction Main Processor Board malfunction	1. Assure that the monitor is being powered by either internal batteries or external battery module. NOTE: Transport Brightness does not vary when monitor is powered by CPS. 2. If problem persists, replace Front Panel Subassembly. 3. If problem persists, replace Main Processor Board Subassembly. 4. If problem persists, return monitor to Siemens for repair or exchange.
> 17 inoperative pixels (“stuck” ON or OFF) on Display.	LCD screen malfunction	Replace Front Panel Subassembly.
Areas of display missing or color contaminated	Graphics Processor on Main Processor Board malfunction	1. Replace Main Processor Board Subassembly. 2. If problem persists, return monitor to Siemens for repair or replacement.
Backlight fails to provide sufficient and consistent background illumination for the LCD display.	Backlight malfunction Front Panel Board malfunction Main Processor Board malfunction	1. Replace Front Panel Subassembly. 2. If problem persists, replace Main Processor Board Subassembly. 3. If problem persists, return monitor to Siemens for repair or exchange.

5.8 MultiMed POD - Parameter Signal Problems

Table 5-8Parameter Signal Problems

Conditions	Possible Cause(s)	Troubleshooting and Remedial Action
Failure to report lead-off condition	MultiMed POD malfunction Front End Board malfunction	1. Replace MultiMed POD. 2. If problem persists, replace Front End Board Subassembly. 3. If problem persists, return monitor to Siemens for repair or exchange.
ECG waveform noise	Incorrect setting of line frequency for customer site Poor connection or intermittent break MultiMed POD malfunction Front End Board malfunction	1. Access the Service Menu under Monitor Setup → Biomed → Service in the Main menu. 2. Assure that the setting is proper for the frequency of the power source at the customer site. 3. If problem persists, check cables, connections, and MultiMed POD for intermittent breaks. • Connect the five (or three) grabber connectors of an ECG lead set to a common conductor, such as the shank of a screwdriver blade, to produce a flatline ECG waveform. • Watch for a distinct change in noise level, indicating the source of the problem, as you flex each lead and cable (particularly at connectors). • Replace a defective ECG lead, cable, or MultiMed POD 4. If no cable, connector, or POD problem, replace Front End Board Subassembly. 5. If problem persists, return monitor to Siemens for repair or exchange.
SpO_2 parameter box fails to appear when sensor plugged into MultiMed POD, or SpO_2 readings missing	Sensor malfunction Open cable or connector MultiMed POD malfunction Front End Board malfunction Main Processor Board malfunction	1. Check illumination of red LED in the sensor. 2. • If LED not illuminated, replace sensor and continue. • If LED illuminated, place sensor on your finger and go to step 6. 3. If problem persists, replace intermediate cable between sensor and MultiMed POD. 4. If problem persists, replace MultiMed POD. 5. If problem persists, replace Front End Board. 6. If problem persists, replace Main Processor Board Subassembly. 7. If problem persists, return monitor to Siemens for repair or exchange.

Table 5-8Parameter Signal Problems (Continued)

Conditions	Possible Cause(s)	Troubleshooting and Remedial Action
SpO_2 waveform noise	Poor connection or intermittent break in cable MultiMed POD malfunction Front End Board malfunction	1. With the SpO_2 sensor on your finger, observe the waveform while you flex the lead and cable, particularly at the sensor, at connectors, and at the MultiMed POD. 2. Watch for a distinct change in the waveform (distinctly different from artifact) as you flex along the length of the cables as well as at the sensor and connectors. 3. Replace a defective sensor , cable or MultiMed POD. 4. If no cable, connector, or POD problem, replace Front End Board Subassembly. 5. If problem persists, return monitor to Siemens for repair or exchange.
Temp parameter box fails to appear when sensor plugged into MultiMed POD, Temp readings missing, or Temp readings inaccurate	Sensor malfunction Open cable or connector MultiMed POD malfunction Front End Board malfunction Main Processor Board malfunction	1. Replace sensor 2. If problem persists, replace MultiMed POD. 3. If problem persists, replace Front End Board. 4. If problem persists, replace Main Processor Board Subassembly. 5. If problem persists, return monitor to Siemens for repair or exchange.

5.9 Visual or Audible Alarm Reporting Failure.

Table 5-9Alarm Malfunctions

Conditions	Possible Cause(s)	Troubleshooting and Remedial Action
Audible Alarm O.K., but Visual Alarm Fails.	Main Processor Board malfunction	1. Replace Main Processor Board Subassembly. 2. If problem persists, return monitor to Siemens for repair or exchange.
Visual Alarm O.K., but Audible Alarm Fails.	Speaker malfunction Front End Board malfunction Main Processor Board malfunction	1. Power-cycle monitor and listen for tone on power-up. 2. • If tone fails to sound, replace speaker subassembly. • If tone sounds, replace Front Panel Subassembly. 3. If problem persists, replace Main Processor Board Subassembly. 4. If problem persists, return monitor to Siemens for repair or exchange.

5.10 Isolating Cabling Malfunctions

In general, the troubleshooting and repair approach is to use a known input signal for any given parameter, and then replace any malfunctioning external cable or sensor. Cable malfunctions, including malfunctions associated with connectors on the cables, generally fall into one of three categories -- open circuits, short circuits, and intermittent connections. Open circuits and short circuits manifest themselves as a loss of signal. Software in the Monitor senses open circuits and short circuits, and generates error messages such as “ECG

Leads Off” and “SpO_2 Transparent.” An intermittent condition in a cable or connector manifests itself as noise on the signal.

5.11 NBP Malfunction

NBP problems can be the result of a malfunction in the cuff assembly, the NBP module, or the monitor itself. Refer to Table 5-10..

Table 5-10NBP Malfunctions

Conditions	Possible Cause(s)	Troubleshooting and Remedial Action
NBP fails to zero properly, fails characterization, or fails calibration check	NBP module malfunction Front End Board malfunction	1. Replace NBP module. 2. If problem persists, replace Front End Board. 3. If problem persists, return monitor to Siemens for repair or exchange.
NBP parameter box fails to appear when cuff hose plugged into NBP module	NBP module malfunction Front End Board malfunction Main Processor Board malfunction	1. With the cuff hose plugged into the NBP module, remove and reinstall the module on the monitor. Assure that the module is properly seated and locked on the monitor. 2. Observe that “NBP Zeroing” appears in the message field at the bottom left-hand side of the display. 3. If message fails to appear, repeat steps 1 and 2 using a known-good NBP module. • If message appears, replace NBP module. • If message fails to appear, replace Front End Board Subassembly. 4. If problem persists, replace Main Processor Board Subassembly. 5. If problem persists, return monitor to Siemens for repair or exchange.
NBP pump fails to start/stop when NBP key on front panel is pressed	Membrane key malfunction Front Panel Board malfunction NBP pump malfunction Front End Board malfunction Main Processor Board malfunction	1. Try substituting a known-good NBP module for the installed module. 2. If problem persists, replace Front Panel Subassembly. 3. If problem persists, replace Front End Board Subassembly. 4. If problem persists, replace Main Processor Board Subassembly. 5. If problem persists, return monitor to Siemens for repair or exchange.
NBP pump starts, but cuff fails to inflate/deflate properly	Cuff assembly malfunction NBP module pump or valves malfunction	1. Recheck cuff assembly and installation. 2. If problem persists, replace NBP module.

5.12 etCO$_2$ Malfunction.

Table 5-11etCO$_2$ Malfunctions

Conditions	Possible Cause(s)	Troubleshooting and Remedial Action
Parameter box fails to appear when sensor plugged into module Sensor fails calibration	Sensor or cable malfunction etCO$_2$ module malfunction Front End Board malfunction Main Processor malfunction	1. Replace etCO$_2$ Sensor. 2. If problem persists, replace etCO$_2$ Module. 3. If problem persists, replace Front End Board subassembly. 4. If problem persists, replace Main Processor suassembly. 5. If problem persists, return monitor to Siemens for repair or exchange.
Persistent Adapter Failure message	Airway adapter or sensor window occluded Airway adapter malfunction Sensor malfunction	1. If adapter or sensor window occluded, clean window. 2. If problem persists, replace airway adapter. 3. If problem persists, replace sensor. 4. If problem persists, replace etCO$_2$ Module.

5.13 IBP, C.O., Wedge, or Temp Readings Missing or Inaccurate

Problems with parameters preprocessed by the HEMO POD, can be the result of a malfunction in a sensor or cabling, the HEMO POD itself, or the monitor. If only one input or output on the HEMO POD fails to function, try replacing the sensor or cable. If problem persists, replace the POD. Refer to Table 5-12...

Table 5-12IBP Malfunctions

Conditions	Possible Cause(s)	Troubleshooting and Remedial Action
IBP or Temp parameter box fails to appear when sensor plugged into HEMO POD	Defective sensor or cable HEMO POD malfunction HEMO POD / Monitor cable malfunction Front End Board malfunction Main Processor Board malfunction	1. With HEMO POD connected to the monitor, assure that parameter labels are visible in LED windows on HEMO POD. 2. • If labels are visible, replace sensor. If problem persists, go on to step 3. • If labels NOT visible, try replacing HEMO POD / Monitor interconnecting cable. If problem persists, continue. 3. If problem persists, replace HEMO POD. 4. If problem persists, replace Front End Board Subassembly. 5. If problem persists, replace Main Processor Board Subassembly. 6. If problem persists, return monitor to Siemens for repair or exchange.

Table 5-12IBP Malfunctions (Continued)

Conditions	**Possible Cause(s)**	**Troubleshooting and Remedial Action**
Zero All key, C.O.Start key or Wedge key on HEMO POD fails to initiate function	HEMO POD malfunction Cable malfunction Main Processor Board malfunction	1. Try replacing HEMO POD / monitor cable. 2. If problem persists, replace HEMO POD 3. If problem persists, replace Main Processor Board Subassembly. 4. If problem persists, return monitor to Siemens for repair or exchange.
IBP fails to zero properly or fails calibration check	Main Processor Board malfunction HEMO POD malfunction Front End Board malfunction	1. Unplug all patient parameter inputs to the monitor. 2. Set Patient simulator for an IBP static pressure = 0 mmHg, and plug simulator into HEMO POD.. 3. Plug HEMO POD output cable into monitor. 4. Check that “Zero Required” appears in the message field and that the IBP parameter box appears on the dislay. 5. • If either the message or the parameer box fails to appear, try replacing HEMO POD and cable. • If problem persistsr, replace Main Processor Board Subassembly. 6. Select IBP parameter field on *MAIN* screen, and assure that Cal Factor is set to 100. 7. Select Zero in the menu, and press in on the rotary knob. 8. • If “Zero Accepted” appears in the message field, continue. • If “--- Did Not Zero” appears in the message field, replace Main Processor Board Subassembly.. 9. Increase simulator pressure to 100 mmHg. 10. If monitor reading $\neq$ 100 ±1 mmHg, replace Main Processor Board Subassembly. 11. If problem persists, return monitor to Siemens for repair or exchange.

5.14 No Printout from Recorder.

Table 5-13Recorder Problems

Conditions	Possible Cause(s)	Troubleshooting and Remedial Action
Power LED on Recorder NOT illuminated	Recorder malfunction cabling malfunction Interface Plate malfunction CPS (if installed) malfunction Power Conversion Board malfunction	1. Assure that all units in the power chain are properly connected and powered ON. 2. If problem persists, detach Interface Plate from Recorder conector and check voltage between pins x and y. 3. If voltage O.K., replace recorder. 4. If voltage NOT O.K., try replacing Interface Plate. 5. • If problem persists, and Recorder is powered from a CPS, continue. • If problem persists and Recorder is powered directly from the monitor, go to step 8. 6. Try replacing the cable between the CPS and the Recorder. 7. If problem persists, replace CPS. 8. Detach the Interface Plate from the Monitor, and check voltage between pins 1 - 2 on the monitor’s docking station connector. 9. • If voltage O.K., replace monitor Interface Plate. • If voltage NOT O.K., replace Power Conversion Board Subassembly

Table 5-13Recorder Problems (Continued)

Conditions	Possible Cause(s)	Troubleshooting and Remedial Action
Local Recorder connected directly to Monitor in standalone configuration	Recorder malfunction Interconnecting cable or connection malfunction Recorder or Monitor Interface Plate malfunction Power conversion Board malfunction Main Processor Board malfunction	1. With an ECG waveform on display, provided by a patient simulator, press Record key. 2. • If “Recorder Not Connected” message appears in the message field, continue. • If “Recorder Not Connected” message fails to appear, replace Front Panel Subassembly and go to step 8. 3. If problem persists, and Recorder Cable Art. No. 4318130E530U is installed, replace Recorder cable and go to step 7. 4. If separate Interface Plates and Recorder cable are installed, replace Recorder Cable. 5. If problem persists, replace Recorder Interface Plate. 6. If problem persists, replace Monitor Interface Plate. 7. If problem persists, replace Recorder. 8. If problem persists, replace Main Processor Board Subassembly. 9. If problem persists, return monitor to Siemens for repair or exchange.
Local Recorder connected to Monitor through CPS	Recorder malfunction CPS - Recorder cable malfunction Recorder Interface Plate malfunction CPS malfunction Docking Station or Bridge Plate malfunction Monitor malfunction	1. With an ECG waveform on display, provided by a patient simulator, press Record key. 2. • If “Recorder Not Connected” message appears in the message field, check the cable and connections between the monitor and CPS, and between the CPS and the Recorder. If problem persists, continue. • If “Recorder Not Connected” message fails to appear, replace Front Panel Subassembly and go to step 5. 3. Substitute Recorder cable Art. No. 4318130E530U in place of Docking Station, CPS, and cabling. 4. • If problem persists, replace Recorder. • If problem disappears, replace each of the components substituted in step 3 to isolate the source of the problem, and replace the malfunctioning component. 5. If problem persists, replace Main Processor Board Subassembly. 6. If problem persists, return monitor to Siemens for repair or exchange.

5.15 SC 9015 or Passive Remote Display - Remote screen fails to replicate monitor display or controls not functioning properly

Table 5-14Remote Display Problems

Conditions	Possible Cause(s)	Troubleshooting and Remedial Action
No display, Power ON LED not illuminated	AC power source malfunction, SC 9015 or Passive Remote Display malfunction	1. Assure that remote unit is plugged into an active hospital power source. 2. If problem persists, check ac voltage at remote end of power cord. 3. If voltage not OK, replace power cord. 4. If problem persists, return remote unit to Siemens for repair or exchange.
No display, Power ON LED illuminated	Remote display cable malfunction Remote unit malfunction CPS or Interface Plate malfunction	1. Assure that remote display cable is securely plugged into Remote Unit and proper connector on CPS (X5) or Interface Plate. 2. If problem persists, replace remote display cable. 3. If problem persists try replacing CPS or Interface Plate. If replacement CPS remedies problem, return CPS to Siemens for repair or exchange. 4. If problem persists, return Remote Unit to Siemens for repair or exchange.
Display replicates SC9000, but one or more control key(s) or optical encoder on SC9015 fails to control related function in monitor	SC9015 malfunction	Return SC9015 to Siemens for repair or exchange.

5.16 Patient-Related Data Not Retained, or Monitor Fails to Compute Trends

1) Replace Main Processor Board Subassembly.
2) If problem persists, return monitor to Siemens for repair or exchange.

Appendix A

Spare / Exchange Parts

External modules and PODS in SC9000 monitoring systems have no internally replaceable components. If malfunctioning, modules and PODS must be returned to Siemens for repair or exchange, see Fig. A-4 and corresponding Table.

The SC9000 monitor is itself exchangeable as a complete unit. Within the SC9000, however, there are basically two exchangeable major subassemblies, the Front Panel Subassembly and the Rear Housing Subassembly, each of which contain a number of other replaceable subassemblies and components. Refer to Figures and corresponding Tables in this appendix for a listing of spare/exchange subassemblies and components. The lists contain all information available as of the publication date of this Manual. Field experience and technological development, however, may require future modifications.

Table A-1 SC9000 Front Panel Subassembly - Replaceable Subassemblies

Item No.	Description	Siemens Article Number
1	E/M SPR SPEAKER SC9000	47 10 062 E522U
2	E/M SPR OPTIC ENCODR SC SERIES (Incl. item 2a)	43 11 622 E533U
2a	E/M SPR ROTARY KNOB SC SERIES	43 16 662 E533U
3	E/M SPR BACKLIGHT 9.5” TFTTV LCD	33 79 844 E522U
	E/M SPR BACKLIGHT 10.4” TFTTV LCD	To Be Determined
4	PCB SPR A120 FRNT PNL SC9000	33 76 964 E522U
	PCB SPR A121 FRNT PNL SC9000	47 26 738 E522U
5	E/M SPR FOOT .40 SQ X .25 THK (Pkg -12)	43 11 374 E533U
6	E/M SPR LNGLBL KIT, SC9000	51 90 843 E522U
	E/M SPR LNGLBL KIT, SC9000 10.4	51 90 835 E522U
7	E/M SPR BEZEL/LENS SC9000	51 90 827 E522U
	E/M SPR BEZEL/LENS SC9000 10.4	51 90 801 E522U
8	E/M SPR FR PNL ASY SC9000 10.4 (incl. items 1 - 7)	47 25 110 E522U

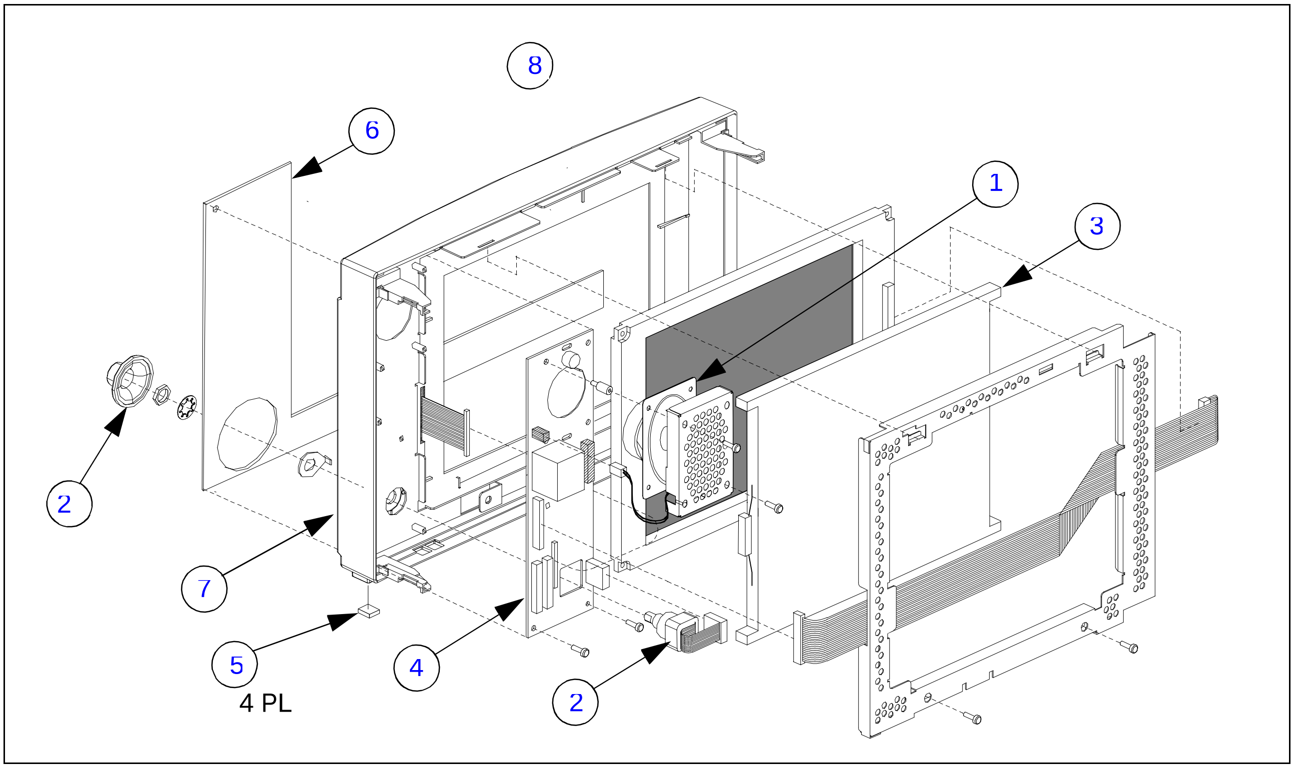

Fig. A-1 SC9000 Front Panel Subassembly w/ 9.5” LCD Display - Replaceable Subassemblies - (see Table A-1).

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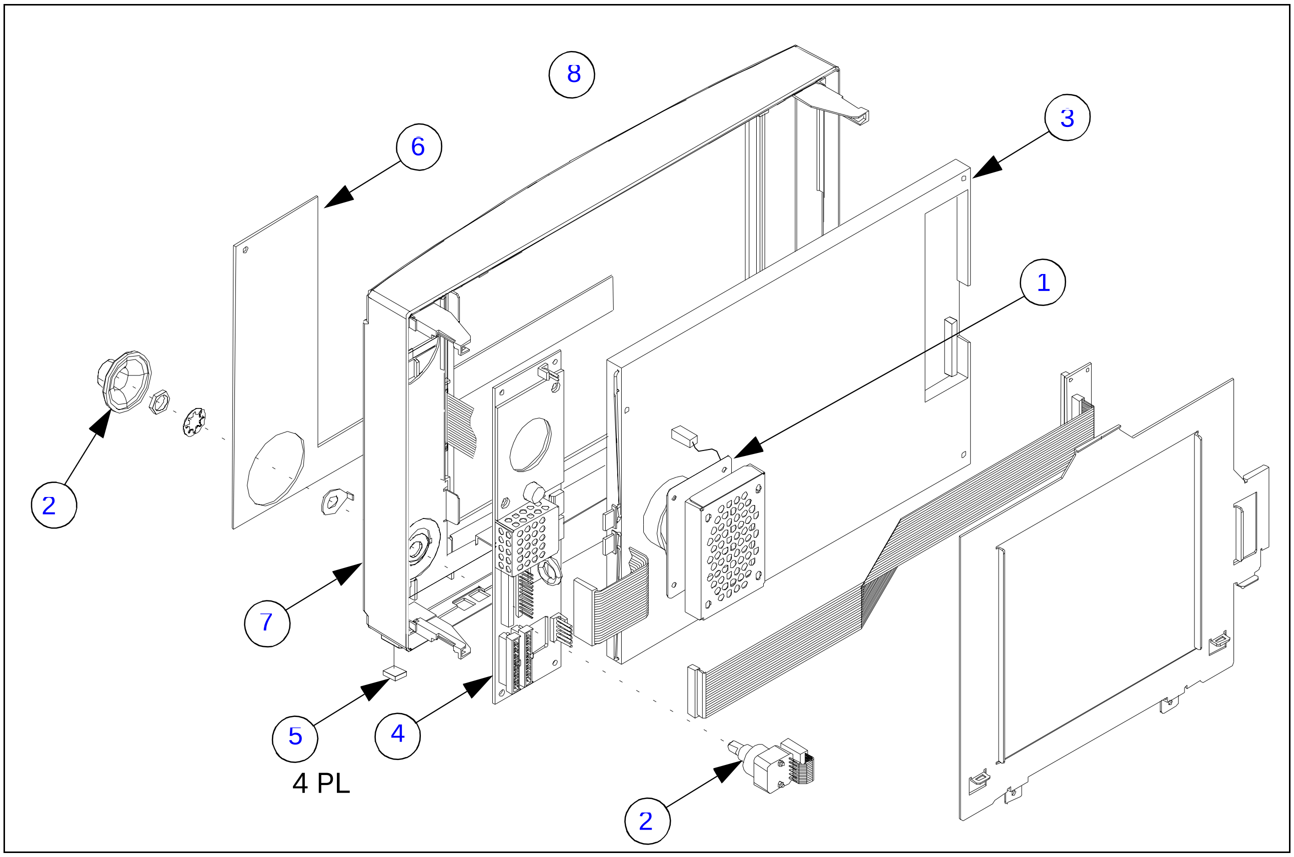

Fig. A-2 SC9000 Front Panel Subassembly w/ 10.4” LCD Display - Replaceable Subassemblies - (see Table A-1).

Table A-2 SC9000 Rear Housing Subassembly - Replaceable Subassemblies and Components

Item No.	Description	Siemens Article Number
11	PCB SPR A102 PROCESSOR SC9000	47 25 045 E522U
12	PCB SPR A130 PWR CVRSN SC9000	33 76 972 E522U
13	E/M SPR FAN ASSY SC9000	47 100 54 E522U
14	PCB SPR A112 FRONT END SC9000	47 21 622 E522U
	PCB SPR A113 FRONT END SC9000	51 89 720 E522U
15	E/M SPR RAM CARD EJECTOR BUTTN (PKG-10)	33 76 865 E522U
16	E/M SPR SIDE BEZEL LEFT SC9000	51 93 946 E522U
17	E/M SPR SIDE BEZEL RT SC9000	33 76 980 E522U
18	E/M SPR BATTERY 6V SC9000	33 77 020 E522U
19	E/M SPR DOOR BATTERY SC9000	33 77 038 E522U
20	Left Side Panel Label Kit	Included with 51 93 946 E522U
21	Right Side Panel Label Kit	Included with 33 76 980 E522U

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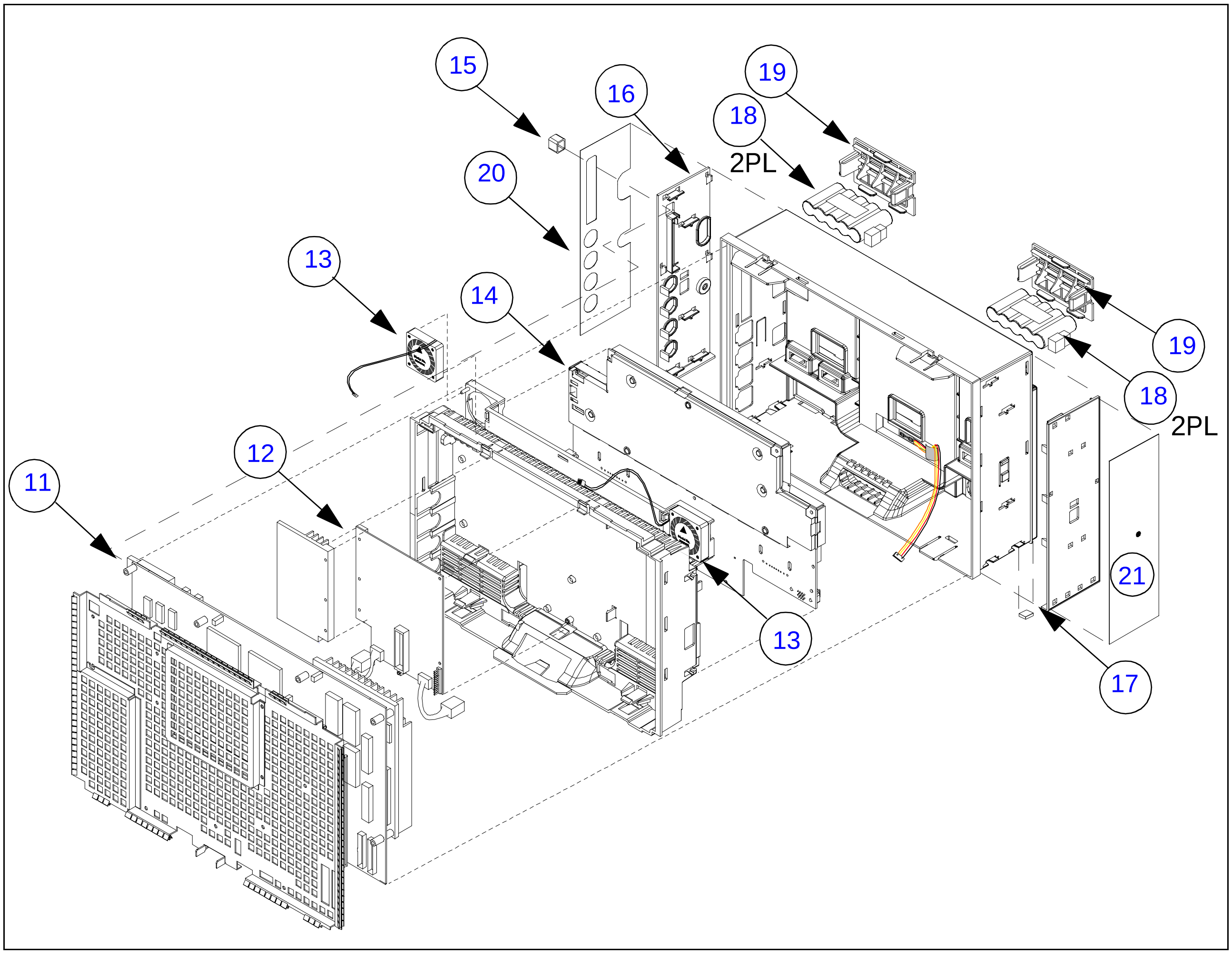

Fig. A-3 SC9000 Rear Housingl Subassembly - Replaceable Subassemblies - (see Table A-2).

Table A-3 Replacement/Exchange Modules and PODS

Item No.	Description	Siemens Article Number
31	SHP EXC SC 9000 ENG	47 28 296 EE56U
	SHP EXC SC 9000 DEU	47 28 288 EE56U
	SHP EXC SC 9000 FRN	47 28 270 EE56U
	SHP EXC SC 9000 SPN	47 28 262 EE56U
	SHP EXC SC 9000 ITA	47 28 254 EE56U
32	DOCK-STN SC SER 2.0M	47 15 343 E530U
33	SHP EXC COM/PWR SUPPLY SIRENET	47 28 973 EE56U
	SHP EXC COM/PWR SIRENET UL/CSA	47 29 013 EE56U
33a	Power Cord Australia, AS 3112	43 21 662 E530U
	Power Cord British, AS 1363	43 21 654 E530U
	Power Cord Cont. Europe, CEE7	43 21 712 E530U
	Power Cord Danish, Afsnit 107	43 21 639 E530U
	Power Cord Italy, CEI 23-16/VII	43 21 621 E530U
	Power Cord India, BS 546	43 21 605 E530U
	Power Cord North America, 5-15R	43 21 720 E530U
	Power Cord Swiss, SEV	43 21 613 E530U
34	SHP ACC MULTIMED ECG TEMP SPO2	33 68 391 E530U
35	SHP EXC BATTERY MODULE SC 9000	47 28 999 EE56U
36	SHP EXC NBP MODULE ENG	47 28 965 EE56U
37	SHP EXC etCO2 Module	47 28 981 EE56U
38	SHP ACC PLATE INTERFACE (Kit)	33 76 493 E530U
39	SHP ACC PLATE BRIDGE TO CPS	33 76 501 E530U
40	SHP EXC HEMO 2 POD	47 29 005 EE56U
41	SHP EXC HEMO 4 POD	47 28 957 EE56U
42	SHP EXC RECORDER R50 - ENG	47 26 548 EE56U
	SHP EXC RECORDER R50 - DEU	47 26 530 EE56U
	SHP EXC RECORDER R50 - FRN	47 26 522 EE56U
	SHP EXC RECORDER R50 - ITA	47 29 419 EE56U
	SHP EXC RECORDER R50 - SPN	47 29 401 EE56U
43	SHP EXC SC9015 REM MONITOR	To Be Determined

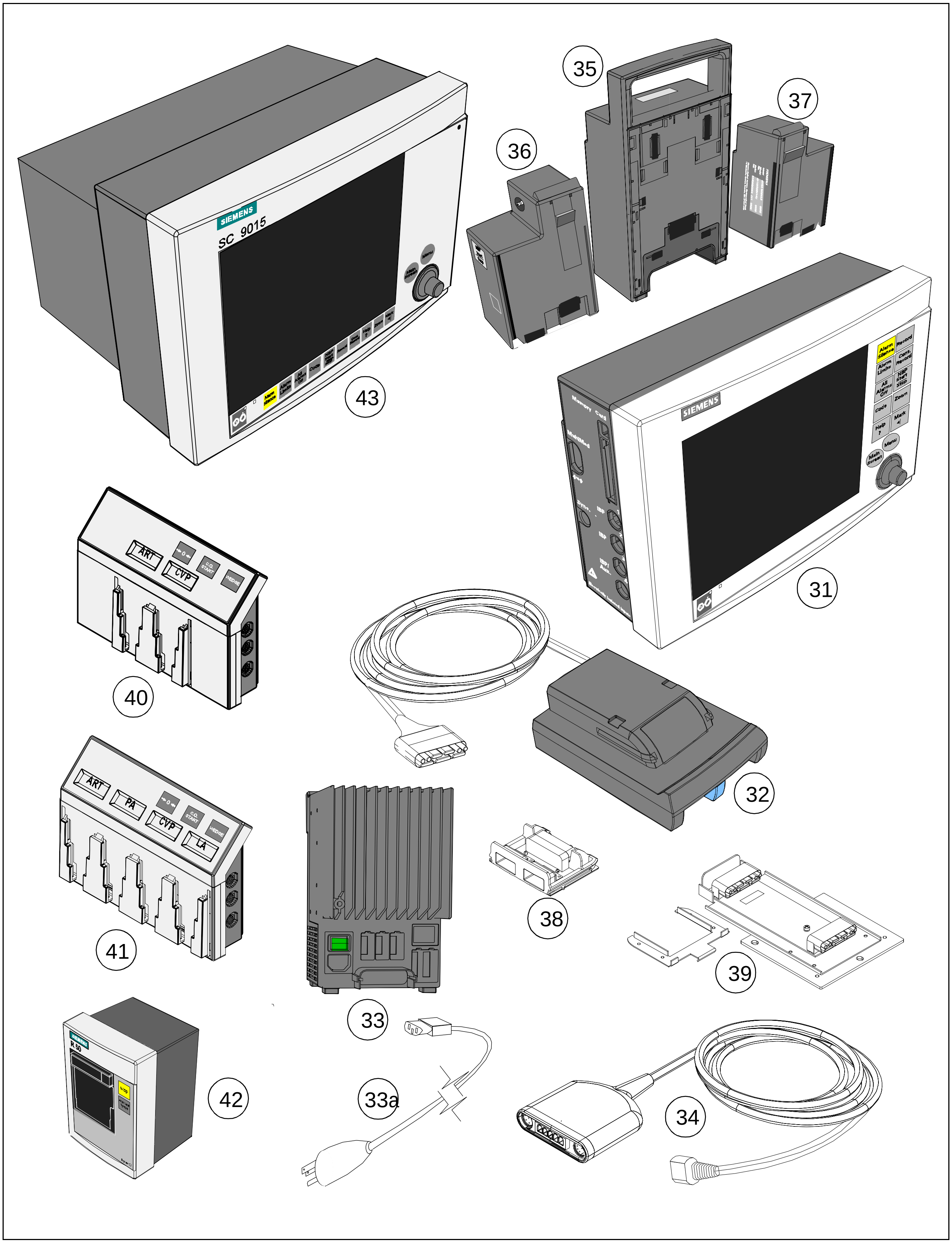

Fig. A-4 SC9000 System Components - Replaceable Modules and PODS - Refer to Table A-3.

Table A-4 R50 Recorder Replaceable Subassemblies and Components

Item No.	Description	Siemens Article Number
51	E/M SPR THERMAL ARRAY 2” RCDR	43 17 157 E527U
52	E/M SPR FRONT BEZEL ASY R50	47 28 114 E527U
52a	E/M SPR FRPNL LNGLBL KIT R50	47 28 106 E527U
53	PCB SPR A100 INTERFACE R50	33 76 659 E527U
54	E/M SPR FOOT RECORDER R50	33 76 683 E527U

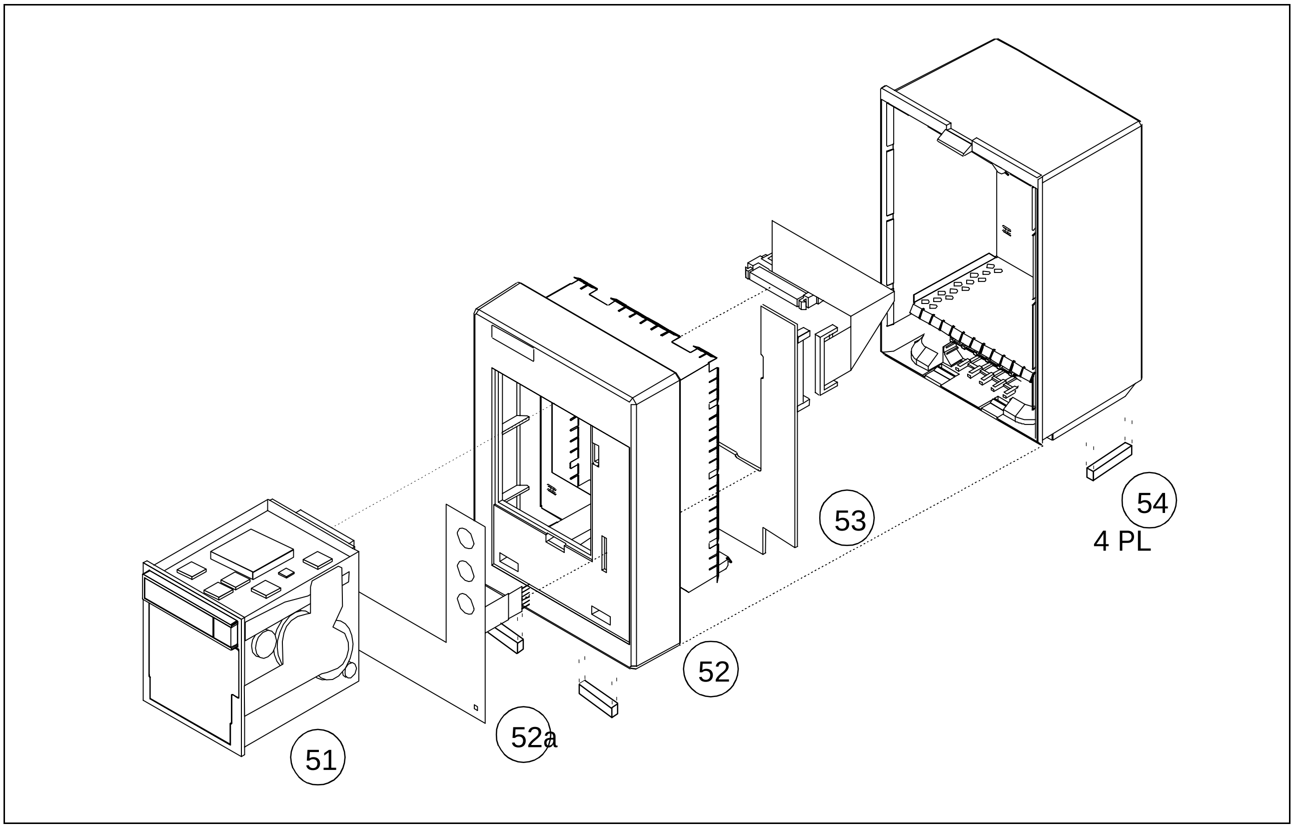

Fig. A-5 R50 Recorder - Replaceable Subassemblies and Components Refer to Table A-4.

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Appendix B

Connector / Cable Pinouts

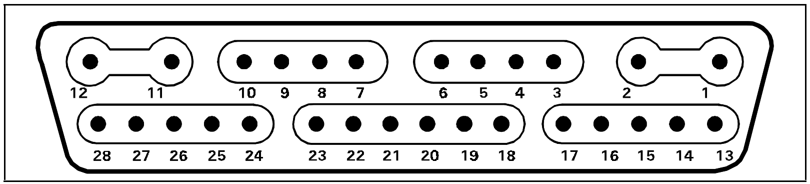


Fig. B-1 SC9000 Docking Station Connector

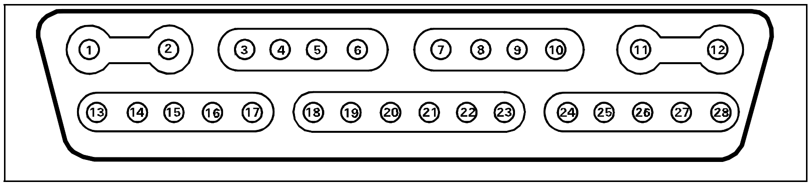


Fig. B-2 Docking Station Connector (Also Bridge Plate - SC9000 Connector)

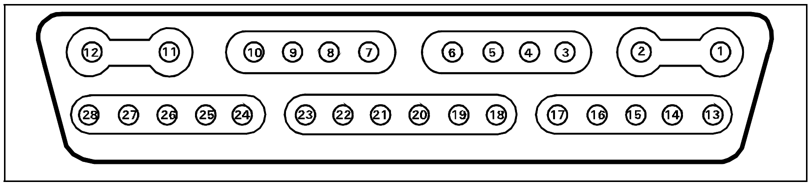


Fig. B-3 Docking Station Cable Connector (Also Bridge Plate - CPS Connector)

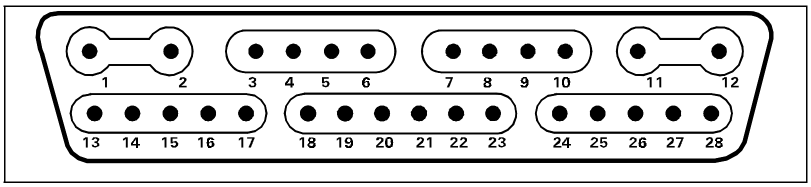


Fig. B-4 CPS Docking Station Cable Connector

Table B-1Docking Station Style Connectors

Pin No.	Signal
1	Vbus
2	GND
3	Remote TxD
4	Remote RxD
5	Remote Audio Ret
6	Remote Audio
7	ALARM Out
8	PSN Detect
9	Debug TxD
10	Debug RxD
11	GND
12	V+
13	Rec RTS
14	Rec CTS
15	Rec TxD
16	Rec RxD
17	GND
18	Ext RED
19	Ext GRN
20	Ext BLU
21	VGND
22	V Sync
23	H Sync
24	Rx–
25	Rx+
26	TX–
27	TX+
28	Power Switch

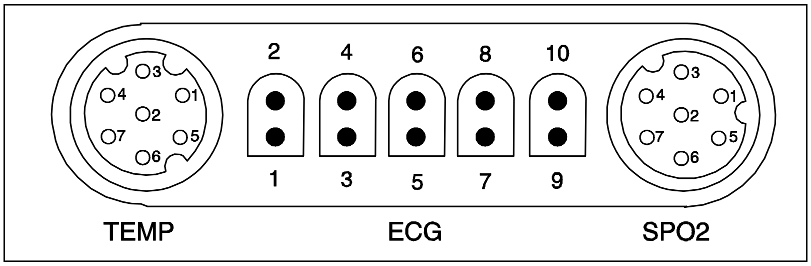


Fig. B-5 MultiMed POD Connector (see Table B-2)

Table B-2 MultiMed POD Connector Pins

Temp		SPO2		ECG			
Pin No.	Signal	Pin No.	Signal	Pin No.	Signal	Pin.No.	Signal
1	TA	1	DETA	1	SHGND	2	LA
2	NC	2	DETK SH	3	SHGND	4	LL
3	TCOM	3	NC	5	SHGND	6	RA
4	NC	4	REDK	7	SHGND	8	V
5	NC	5	RCALRTN	9	SHGND	10	RL
6	NC	6	RCALIB				
7	NC	7	IRK				

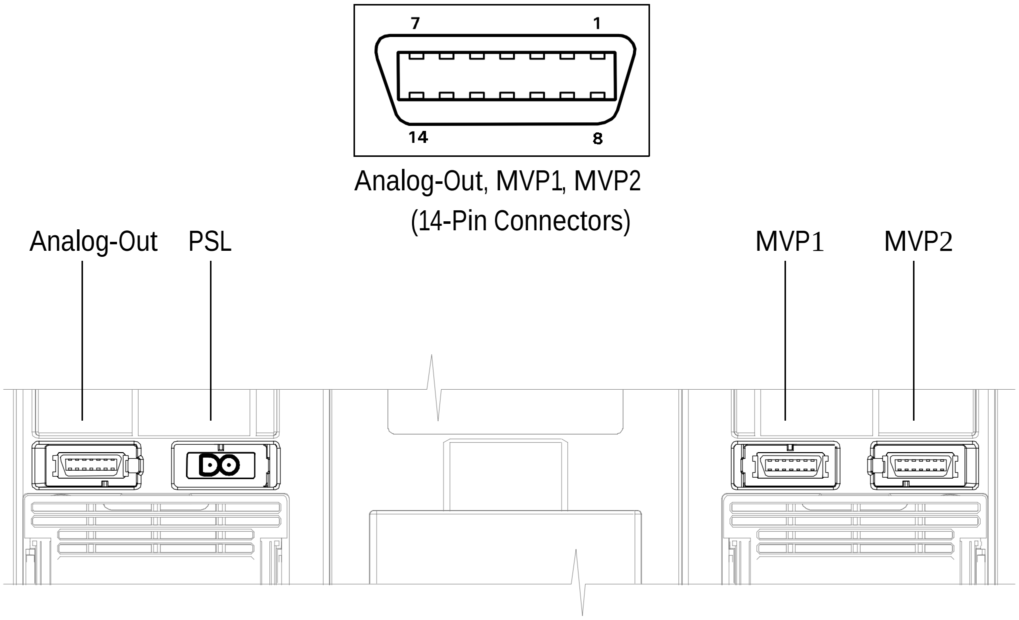


Fig. B-6 SC9000 Conectors on Back of Rear Housing (see Table B-3)

Table B-3 SC9000 Connector Pins

Analog-Out (X10)		PSL (X11)		MVP1 (X8)		MVP2 (X9)	
Pin No.	Signal	Pin No.	Signal	Pin No.	Signal	Pin.No.	Signal
1	GND	1	GND	1	GND	1	GND
2	Hd Audio Out	2	PWR	2	TxData COM-1	2	TxData COM-2
3	Hd Audio Rtn			3	Rem Kbd Pwr	3	Rem Kbd Pwr
4	NC			4	MCBootL	4	
5	Diag TxD			5		5	
6	Chan2 Rtn			6	Ser Dout	6	
7	Chan2 Analg			7	Ser FSL	7	
8	Hd Audio Det			8	RxData Com-1	8	RxData COM-2
9	AGND			9	Alarm Out	9	Alarm Out
10	AGND			10	GND	10	GND
11				11	HWBoot1	11	
12	Chan1 Anlg			12	Ser Din	12	
13	Chan1 Rtn			13	Ser CLK	13	
14	Diag RxD			14	GND	14	GND

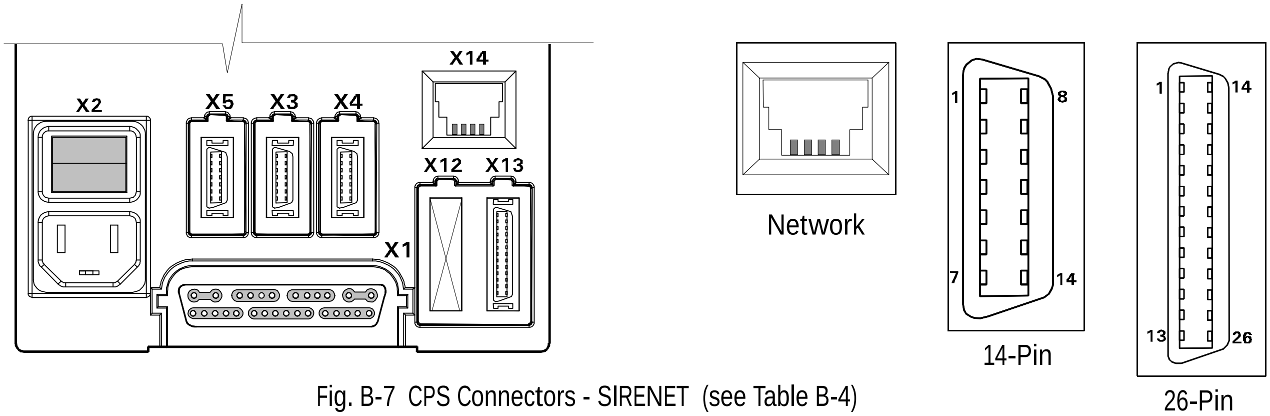


Fig. B-7 CPS Connectors - SIRENET (see Table B-4)

Table B-4SIRENET CPS Connector Pins

ALM/KB/DIAG/COMM-1 (X3)		ALM/KB/DIAG/COMM-2 (X4)		External CRT (X5)		Network (X14)		Recorder (X13)	
Pin No.	Signal	Pin No.	Signal	Pin No.	Signal	Pin.No.	Signal	Pin.No.	Signal
1	GND	1	GND	1	Ext Red	1	SIRENET 1	1	AUX1 TxD
2	Tx Data KB	2	Tx Data KB	2	VGND	2	SIRENET 2	2	AUX Pwr
3	Rem Kbd Pwr	3	Rem Kbd Pwr	3	Ext Grn	3	Bed Conn	3	AUX1 RxD
4		4		4	VGND	4	QRS Sync	4	AUX Pwr
5	Diag TxD	5	Diag TxD	5	Ext Blu			5	AUX1 CTS
6		6		6	VGND			6	AUX Pwr
7		7		7	GND			7	AUX1 RTS
8	RxData KB	8	RxData KB	8	H-Sync			8	AUX Pwr
9	Alarm Out	9	Alarm Out	9	V-Sync			9	
10	GND	10	GND	10	Remote TxD			10	AUX Pwr
11		11		11	Remote RxD			11	AUX ID0
12	COMM-1 Rx	12	COMM-2 Rx	12	Pwr Switch			12	AUX ID1
13	COMM-1 Tx	13	COMM-2 Tx	13	Rem Audio			13	AUX ID2
14	Diag RxD	14	Diag RxD	14	Rem Audio Ret			14	AUX P Enb
								15	P GND
								16	AUX Tx+
								17	P GND
								18	AUX Tx-
								19	P GND
								20	AUX Rx+
								21	P GND
								22	AUX Rx-
								23	P GND
								24	
								25	GND
								26	GND

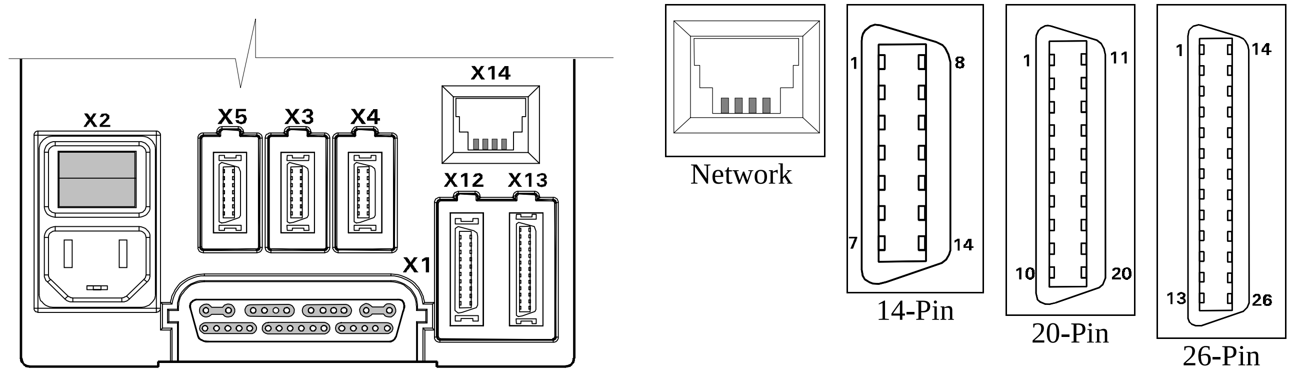


Fig. B-8 CPS Connectors - INFINITYNET (see Table B-5)

Table B-5 INFINITYNET CPS Connector Pins

ALM/KB/DIAG/COMM-1 (X3)		ALM/KB/DIAG/COMM-2 (X4)		External CRT (X5)		AUX/MIB/CANBUS(X12)		Recorder (X13)	
Pin No.	Signal	Pin No.	Signal	Pin No.	Signal	Pin.No.	Signal	Pin.No.	Signal
1	GND	1	GND	1	Ext Red	1	MIB1 D+	1	R50A TxD
2	Tx Data KB	2	Tx Data KB	2	VGND	2	MIB1 Pwr	2	AUX Pwr2
3	Rem Kbd Pwr	3	Rem Kbd Pwr	3	Ext Grn	3	MIB1 D-	3	R50A RxD
4	ISD Power	4	ISD PWR	4	VGND	4	MIB2 Pwr	4	AUX Pwr2
5	Diag TxD (CPS)	5	Diag TxD	5	Ext Blu	5	MIB1 S+	5	R50A CTS
6	DEBUG1	6	MCBOOTL	6	VGND	6	CAN+	6	AUX Pwr2
7	ISD GND	7	ISD GND	7	GND	7	MIB1 S-	7	R50A RTS
8	RxData KB	8	RxData KB	8	H-Sync	8	CAN R_L	8	AUX Pwr2
9	Alarm Out	9	Alarm Out	9	V-Sync	9	AUX1 ID0	9	
10	GND	10	GND	10	Remote TxD	10	AUX1 ID1	10	AUX Pwr2
11	HWBootL	11	NMI	11	Remote RxD	11	AUX1 ID2	11	AUX2 ID0
12	COMM-1 Rx	12	COMM-2 Rx	12	Pwr Switch	12	MIB2 D+	12	AUX2 ID1
13	COMM-1 Tx	13	COMM-2 Tx	13	Rem Audio	13	GND	13	AUX2 ID2
14	Diag RxD	14	Diag RxD	14	Rem Aud Ret	14	MIB2 D-	14	AUX2 P Enb
						15	GND	15	P GND
						16	MIB2 S+	16	R100A TxD+
						17	GND	17	P GND
						18	MIB2 S-	18	R100A TxD-
						19	CANBUS+	19	P GND
						20	Chassis GND	20	R100A RxD+
								21	P GND
								22	R100 RxD-
								23	P GND
								24	
								25	Chassis GND
								26	Chassis GND

Network (X14)	
Pin No.	Signal
1	TxD+
2	TxD-
3	RxD+
4	RxD-

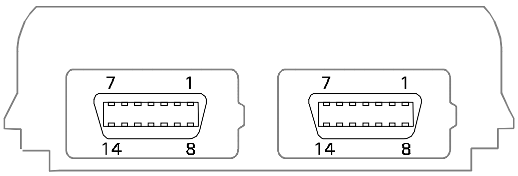


Fig. B-9 Interface Plate - Rear View (see Table B-6)

Table B-6 Interface Plate Rear Connectors

Pin No.	RECORDER/ALARM	EXT CRT
1	GND	Ext Red
2	+12VDC	VGND
3	Rec Tx	Ext Grn
4	+12VDC	VGND
5	Diag Tx	Ext Blu
6	+12VDC	VGND
7	Rec RTS	GND
8	Rec CTS	H Sync
9	Alarm Out	V Sync
10	Rec GND	Rem TxD
11	Rec GND	Rem RxD
12	Rec Rx	Power Switch
13	Rec GND	Rem Audio
14	Diag Rx	Rem Audio Ret

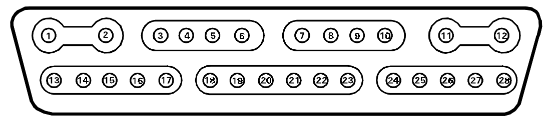
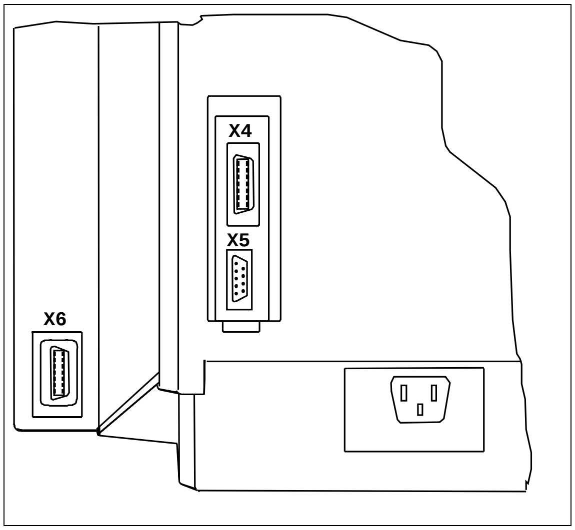
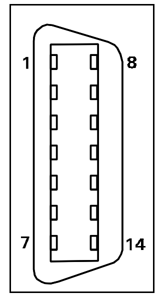


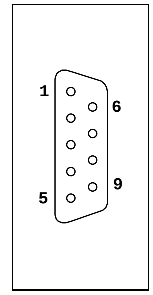
Fig. B-10 Interface Plate Connector (see Table B-7)

Table B-7 Interface Plate Connector

Pin No.	Signal
1	VBUS
2	GND
3	Rem TxD
4	Rem RxD
5	Rem Audio Ret
6	Rem Audio
7	Alarm Out
8	CPS Detect
9	Debug TxD
10	Debug RxD
11	GND
12	V+
13	Rec RTS
14	Rec CTS
15	Rec TxD
16	Rec RxD
17	GND
18	Ext Red
19	Ext Grn
20	Ext Blu
21	VGND
22	V Sync
23	H Sync
24	RX-
25	RX+
26	TX-
27	TX+
28	Power Switch







X4, X6 (14-Pin) X5 (9-Pin)

Fig. B-11 SC 9015 Remote Display - Rear View (see Table B-8)

Table B-8 SC9015 Remote Display Connector Pins

Video/Audio/FrontPanel (X4)		X-Terminal Video (X5)		Remote Keyboard (X6)	
Pin No.	Signal	Pin No.	Signal	Pin No.	Signal
1	Ext Red	1	Ext Red	1	GND
2	VGND	2	VGND	2	TxData COM
3	Ext Grn	3	Ext Grn	3	Rem Kbd Pwr
4	VGND	4	VGND	4	
5	Ext Blu	5	Ext Blu	5	
6	VGND	6	VGND	6	
7	GND	7	GND	7	
8	H-Sync	8	H-Sync	8	RxData COM
9	V-Sync	9	V-Sync	9	
10	Remote TxD			10	GND
11	Remote RxD			11	
12				12	
13	Remote Audio			13	
14	Remote Audio Ret			14	GND

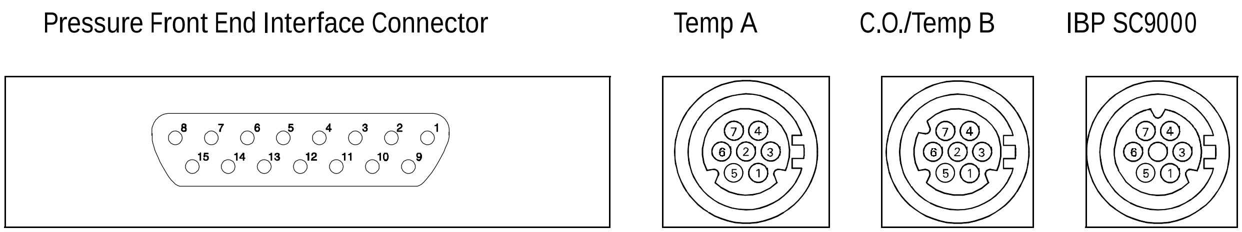


Fig. B-12HEMO POD Connectors (see Table B-9)

Table B-9Connector Signals

Pin No.	PRESSURE FRONT END INTERFACE	Temp A	C.O./Temp B	IBP SC9000
1	+SIG (P1)	TEMP 1	TEMP 2	CNTRLH
2	GND	GND		
3	GND	GND	GND	CNTRLL
4	+EXCIT (P1)	GND	.7R37	DATH
5	+EXCIT (P2)	GND	TBLD	VDCRTN
6	GND	GND	TINJ	VDC
7	GND	GND	GND	DATL
8	+SIG (P2)			
9	-SIG (P1)			
10	GND			
11	-EXCIT (P1)			
12	GND			
13	-EXCIT (P2)			
14	GND			
15	-SIG (P2)			

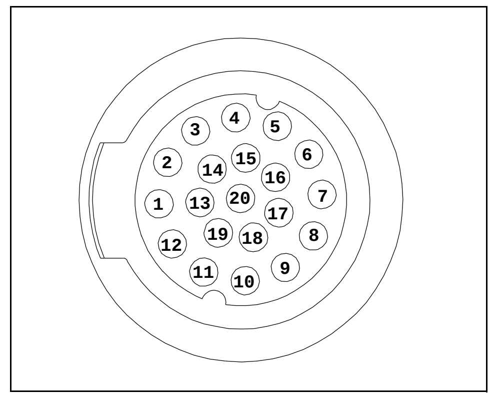


Fig. B-13etCO_2 Input Connector (see Table B-10)

Table B-10etCO_2 Moduile Input Connector Pins

Pin No.	Signal
1	SRC-
2	SRC+
3	EE CS
4	REF IN
5	CASE HTR
6	DATA IN
7	EE SK
8	HTR RTN
9	EE DOUT
10	+5V
11	EE DIN
12	SPAN SW
13	SRC SHLD
14	ZERO SW
15	CASE THRM
16	DET HTR
17	DET THRM
18	-12V
19	+12V
20	AGND

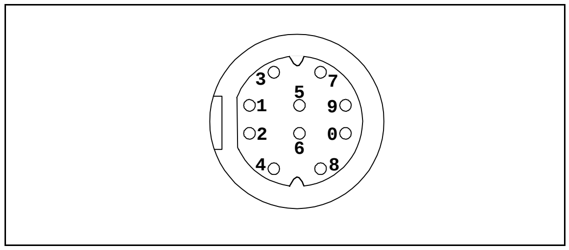


Fig. B-14HEMO POD PRESS Adapter Input (see Table B-11)

Table B-11PRESS Input Connector

Pin No.	A, B, C, D	Pin No.	A, B, C, D
1	+EXCIT	6	+SIGNAL
2		7	
3	-EXCIT	8	GND
4	Cable In	9	
5	-SIGNAL	0	

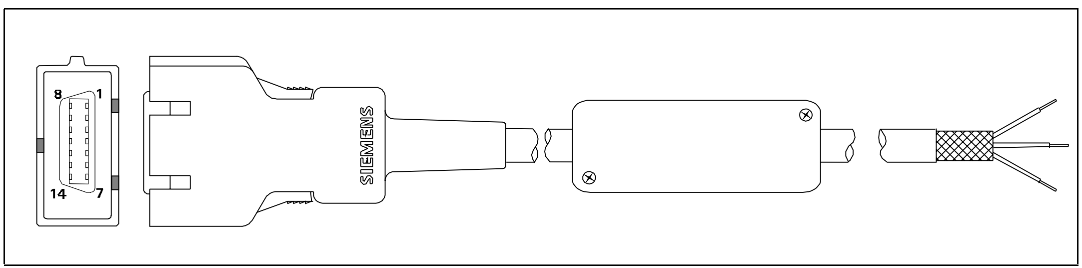


Fig. B-15 SHP ACC CBL ALARM UNTERM 5M (see Table B-12)

Table B-12 Remote Alarm Cable Color Code

Color Code			
Connector Pin No.	Relay Input Wire Color	SPDT Relay Output	Circuit Status
1	TAN	Brown	RTN
2	NC	Green	Inactive Open
3	NC	White	Inactive Closed
4	NC		
5	NC		
6	NC		
7	NC		
8	NC		
9	ORANGE		
10	NC		
11	NC		
12	NC		
13	NC		
14	NC		

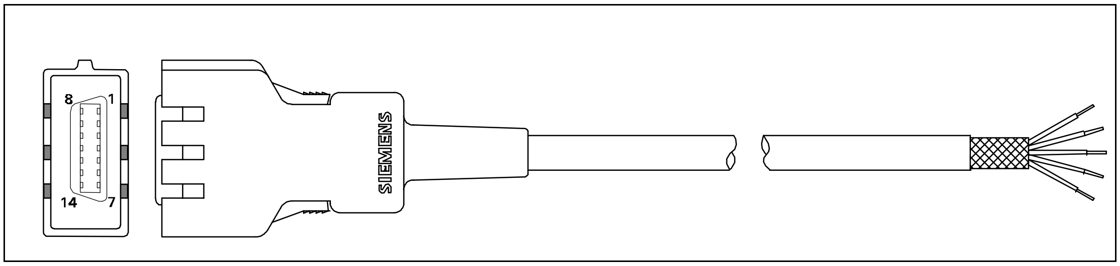


Fig. B-16SHP ACC CBL 14P UNIVERSAL (see Table B-13)

Table B-13Universal Cable Color Code

Color Code	
Connector Pin No.	Wire Color
1	TAN
2	WHITE
3	BLACK
4	RED
5	GREEN
6	YELLOW
7	BLUE
8	BROWN
9	ORANGE
10	GREY
11	VIOLET
12	PINK
13	LT BLUE
14	LT GREEN

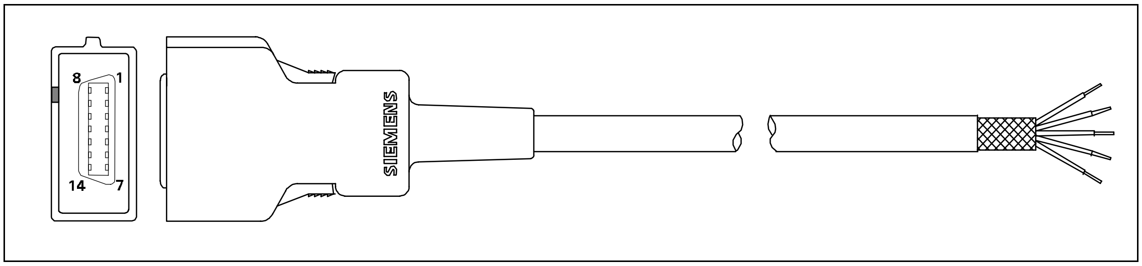


Fig. B-17 SHP ACC CBL ANALOG UNTERM 5M (see Table B-14)

Table B-14 Analog Cable Color Code

Color Code		
Connector Pin No.	Wire Color	Function
1	TAN	NC
2	WHITE	NC
3	BLACK	NC
4	RED	NC
5	GREEN	NC
6	YELLOW	CHAN 2 RTN
7	BLUE	CHAN 2 ANLG
8	BROWN	NC
9	ORANGE	NC
10	GREY	NC
11	VIOLET	NC
12	PINK	CHAN 1 ANLG
13	LT BLUE	CHAN 1 RTN
14	LT GREEN	NC

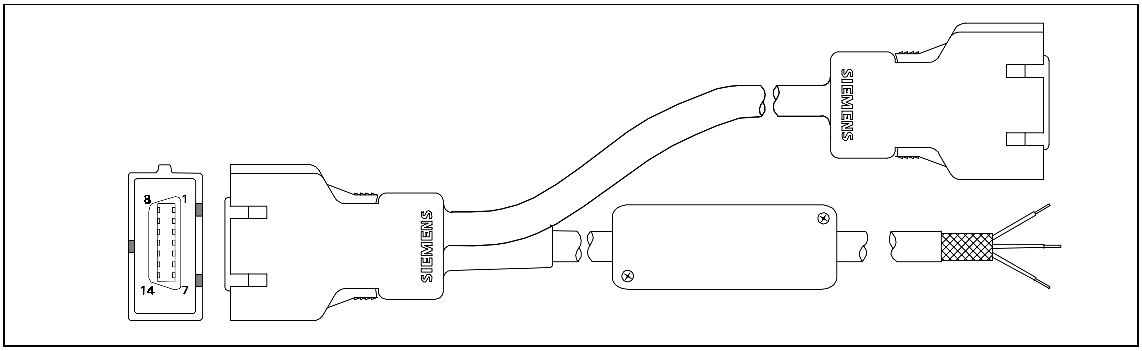


Fig. B-18 SHP ACC CBL Y RECORDER/ALARM (see Table B-15)

Table B-15 Recorder/Alarm Y Cable Color Code

Color Code (Alarm Cable)			
Connector Pin No.	Relay Input Wire Color	SPDT Relay Output	Circuit Status
1	TAN	Brown	RTN
2	NC	Green	Inactive Open
3	NC	White	Inactive Closed
4	NC		
5	NC		
6	NC		
7	NC		
8	NC		
9	ORANGE		
10	NC		
11	NC		
12	NC		
13	NC		
14	NC		

Appendix C

Diagnostic Messages

C.1 Overview of Diagnostic Messages

The diagnostic codes given in C-1 may appear in an SC 9000's on-screen Diagnostic Log, and help in troubleshooting a malfunctioning SC 9000. Both possible cause and suggested remedial action are listed for the field-significant codes.

Only codes for field-related procedures are given in the Table. There are also a number of other diagnostic codes, not listed in the Table, that have significance for engineering in helping to improve product performance. **If observed, report these codes to engineering via a Data-Card**. Refer to Chapter 1, Section 1.11, for the procedure to download the Diagnostic Log to a DataCard.

To access the Diagnostic Log, on the Main Menu select BIOMED, then DIAG. LOG.

Diagnostic messages caused by an error condition can be generated by four sources:

- Replaceable hardware malfunction, such as an NBP Module or HEMO POD
- Software error
- Intermittent condition
- Hardware error

Notes for Table C-1:

1) When action says replace..., do so only if problem can be reproduced.
2) Convention of A, B, C etc. in the messages given in the Description column is an abbreviation of actual messages, which will have numbers in place of the A, B, C, etc., that help engineers uncover the actual cause.
3) When action says "upgrade to Vxx," problem can also be solved by upgrading to any SW version released after Vxx.

Table C-1 Diagnostic Log Codes

Code	Description	Cause	Action
800c9009H	atten OOR = A cal factor = B	Speaker too quiet	Replace speaker
800c9022H	cal factor=A max_sample_value=B	Speaker broken	Replace speaker
800cd007H	Loopback Active = A Expect Active =B	Hardware malfuction in "nurse call" circuit.	Check "Nurse Call" circuit.
800d3015H	cath_manufactorer=A	SW Error	Upgrade to ≥VA2 software.
800d8001H	this = A, state b, event c	Lead set / Multimed failure	Replace MultiMed / Lead set
800d8003H	evec = A, cable = B, neutdrv = C ==> neutsel_1 = D	Lead set / Multimed failure	Replace MultiMed / Lead set

Table C-1 Diagnostic Log Codes (Continued)

Code	Description	Cause	Action
800d8004H	Shutting down QRS Sync; Pod S/N =	Shorted QRS sync cable or shorted connector	Replace QRS sync cable or Front End Board
800d8006H	Shutting down QRS Sync; Pod S/N =	Shorted QRS sync cable or shorted connector.	Replace QRS sync cable or shorted connector.
800da0cdH	event A, state B	Power stuck on or off.	Look at hardware in this order; FE board, cable, CPU.
800db006H	Status: A	$etC0_2$ cartridge not responding. Digital board may have a problem.	Replace cartridge.
800db009H	Sensor sn: A	Current to $etC0_2$ sensor is too high or too Low	Replace sensor or cartridge.
800e4000H	Invalid acquire object id	S/W Error	Upgrade to ≥VA2 software.
800e6004H	mean_cal_on = A, mean_cal_off = B, expected diff = C, tolerance = C	Respiration loopback failed	Replace Front End Board
800e6005H	Resp Test failed on Pod S/N =	Respiration loopback failed	Replace Front End Board
800e700bH	Pod S/N=	SP02 loopback test at power up.	Replace Front End Board.
800fb044H	ANP - data starvation	SW error	Upgrade to ≥VA2 software.
8011a002H	sync word=A	CPU failure	Replace front end board.
8011a005H	S/N=A, mean oor=B, smpl oor=C	ECG calibration Injection failed	Replace Front End Board
8011a006H	S/N=, Fail Mask=A Nominal=-b Observed=C	Power Supply or Front End Board failed.	Replace Power Supply or Front End Board.
8011a00aH	S/N=, ref_low=-a, ref_high=B	BAD TEMP REP	Replace Front End Board
80127004H	bkg_operational determined MONITORING SW is corrupt.	Background entity determined that the Main Software was corrupted (BAD CRC)	Re-download monitor software. If problem persists then replace Main Processor Board.
80127005H	bkg_operational determined BOOT SW is corrupt.	Background entity determined that the Main Software was corrupted (BAD CRC)	Re-download monitor software. If problem persists then replace Main Processor Board.
80129014H	boot_program_CPS_images failed with status: A on 68302 image.	CPS flash memory could not be programmed with new software	Re-download CPS software. If problem persists exchange CPS.

Table C-1 Diagnostic Log Codes (Continued)

Code	Description	Cause	Action
8012901eH	boot_validate_download_card could not open/close one of the boot files.	Software memory card may have been removed during a download or the card may have become corrupted	Re-download monitor software. If problem persists, replace memory card.
80148008H	start_addr = a, put_addr = b, get_ptr = c, buf_ptr = d.	SW Error	Upgrade to ≥VA2 software.
8014800cH	dbal_corrupt_code = A gdoclass = B	SW error	Upgrade to ≥VB software.
80148010H	transaction_start_addr = A, transaction_get_ptr=B	SW Error	Upgrade to ≥VB software.
8016a004H	H8344 failed dm_test	SW error	Upgrade to ≥VA2 software.
8016a00aH	Image checksum test failed due to TAXI error!	Bad memory/access/fetch	Restart monitor. If error persists exchange monitor.
8016a015H	dml_notify_requestors called from intr level 6 for device = A:B	SW error	Upgrade to ≥VA2 software.
8016a027H	Device must be marked available before being marked ready	SW Error	Upgrade to ≥VA2 software.
8016a031H	Test Failed! 8344 software incompatible!	SIRENET CPS incompatable	Power cycle monitor. If error persists, exchange CPS.
80175003H	a b c d e	SW error	Upgrade to ≥VA1.1 software.
80179001H	Test System Fault Error!	CPU board failed	Replace Main Processor board
8017901eH	DSP IRQ not recv'd, detected = A	CPU board failed	Replace Main Processor board
8017901fH	Bad DSP IRQ pattern, expected = A, detected = B	CPU board failed	Replace Main Processor board
80179065H	DSP error status: A, DSP error logged: B	DSP has timed out	Replace Main Processor board if error persists
80179068H	DSP error status: A, DSP error logged: B	DSP has timed out.	Replace Main Processor board if error persists
8018301fH	Unable to update CPS Chassis with pick_n_go_mode	Write failed to CPS chassis EEPROMs	Exchange CPS
80187020H	Error Log was cleared!	Manual clear of error log via system console menu	None
8018d005H	sn A, status B	etCO_2 Hardware Fail	Replace etCO_2 cartridge.
8018f016H	Level 7 Auto Vector: SR=A PC=B	CPU board failed	Replace Main Processor Board
80196005H	boot_erase_CPS_image failed to erase FLASH with status: A	CPS flash mem failure	Check Docking Station connection. Retry download. Exchange CPS if error persists.

Table C-1 Diagnostic Log Codes (Continued)

Code	Description	Cause	Action
80196006H	Chip timed out at: A wrote: B, read: C	Flash memory failed tests when doing a download. Bit one is always on.	Re-download software. If problem persists then replace Main Processor Board if downloading monitor, or exchange CPS if downloading CPS.
8019601dH	Flash program write verify failed at A. wrote: B, read: C	Monitor flash failed tests when doing a download	Re-download software. If problem persists, replace Main Processor Board.
8019700cH	time=A	Heart blip not showing; most likely due to rapid screen re-draws	Ignore
8019a001H	dnldm_produce_gdo_sw_install_card_version unable to open h_package_id	Memory card failure	Retry download. If error persists, return card.
8019a002H	dnldm_produce_gdo_sw_install_card_version unable to open h_package_id	Memory card failure	Retry download. If error persists, return card.
8019a00bH	dnldm_produce_gdo_sw_install_card_version unable to open h_package_id	Memory card problem.	Retry download. If error persists, return card.
8019a013H	dnldm_produce_gdo_sw_install_card_version unable to open h_package_id	Memory card problem	Retry download. If error persists, return card.
801ac00bH	Pod Type A Conn B, S/N=C, event D state E	Pod would not power on or off. Connector number in description string are: 0-front end board 1,2,3-hemo pod 4-reserved 5-etCO_2 6-nibp cartridge	Check/replace in this order pod/cartrige, cable, Main Processor Board.
801ac00cH	Pod Type A, Conn B, S/N=C, event D state E	Comm error, CRC error	IF problem persists, check connector or replace pod
801b7000H	ERROR: load_34010	34010 Failure	Replace Main Processor Board
801b7001H	ERROR: load_34010	34010 Failure	Replace Main Processor Board.
801b8000H	GFX_INT=A, HSTADR=B, HSTCTL=C, HSTDATA=D, ADDRESS=E.	SW Error in 34010	Upgrade to ≥VA2 software.
801c7012H	Test Failed! TAXI became Unavailable	Expected condition, not an error	Ignore.
801c8026H	Image control checksum error! Computed: A Stored: B	CPS 8344 image is corrupt	Re-download CPS software. If problem persists, exchange CPS.
801c8027H	FLASH IMAGE CORRUPTED!	CPS 8344 image is corrupt	Re-download CPS software. If problem persists, exchgnae CPS.

Table C-1 Diagnostic Log Codes (Continued)

Code	Description	Cause	Action
801c802cH	Download failed! Address: A Written: B Read: C	CPS 8344 image is corrupt.	Re-download CPS software. If problem persists, exchange CPS.
801e3004H	ipcl send status=A sendent=B destent=C	SW Error	Upgrade to ≥VA2 software.
801e7006H	Periph BUS Error! Illegal Address! Periph. Bus granted to DSP DMA! Latched addr bits 27-18=A	CPU board failure with peripheral bus	Replace Main Processor Board.
801e7007H	DRAM Parity Error! BYTES:A in error!	Bad DRAM or incompatible xylinx parts	Replace Main Processor Board.
801e8001H	im_instl_generic_intr failed! intr_id=A	Monitor with software of VA2 or lower was attached to an Infinity CPS	Either upgrade software to ≥VBx software or use a SIRENET CPS.
80231002H	LCOM_BAD_PRL_SUPPLIED_ERROR	SW or comm error between CPS and Monitor	Check cable connection. If no second error, exchange CPS.
80231005H	LCOM_BAD_SWITCH_COUNT_ERROR	Comm error	If this message is accompanied by another error, check Docking station connections. Otherwise this indicates a SW error and should be reported to Customer service via DataCard.
8023100aH	LCOM_CHECKSUM_DIAG_ERROR	Comm error	If this message is accompanied by another error, then check Docking station connections. Otherwise this indicates a SW error and should be reported to Customer service via DataCard.
80231014H	LCOM_INCOMPATIBLE_8344_SW_REV	Hardware incompatible	Reboot monitor and CPS, if problem persists exchange CPS.
80231015H	LCOM_INVALID_RIU44_LOW_EF	SW Error	Upgrade to ≥VA1.1 software.
80231025H	LCOM_PRL_ENTRY_DIAG_ERROR	CPS harware failure	Reboot monitor and CPS. If problem persists, exchange CPS.
80231026H	LCOM_PRL_ID_DIAG_ERROR	CPS hardware failure.	Reboot monitor and CPS. If problem persists, exchange CPS.

Table C-1 Diagnostic Log Codes (Continued)

Code	Description	Cause	Action
80231029H	LCOM_Q_TO_8344_DIAG_ERROR	Net comm failure	If this message is accompanied by another error, check Docking station connections. Otherwise this indicates a SW error and should be reported to Customer service via DataCard.
8023102bH	LCOM_RAM_DIAG_ERROR	Net comm failure	If this message is accompanied by another error, check Docking station connections. Otherwise this indicates a SW error and should be reported to Customer service via DataCard.
8023102cH	LCOM_ROM_DIAG_ERROR	Net comm failure	If this message is accompanied by another error, check Docking station connections. Otherwise this indicates a SW error and should be reported to Customer service via DataCard.
8023102eH	LCOM_SHRAM_CHECKSUM_ERROR	Net comm failure	If this message is accompanied by another error, check Docking station connections. Otherwise this indicates a SW error and should be reported to Customer service via DataCard.
80231030H	LCOM_SHRAM_DIAG_ERROR	Net comm failure	If this message is accompanied by another error, check Docking station connections. Otherwise this indicates a SW error and should be reported to Customer service via DataCard.
80231031H	LCOM_SHRAM_PACKET_ERROR	Net comm failure	If this message is accompanied by another error, check Docking station connections. Otherwise this indicates a SW error and should be reported to Customer service via DataCard.

Table C-1 Diagnostic Log Codes (Continued)

Code	Description	Cause	Action
80231032H	LCOM_SHRAM_PRL_ERROR	net comm failure	If this message is accompanied by another error, check Docking station connections. Otherwise this indicates a SW error and should be reported to Customer service via DataCard.
80231034H	LCOM_SIRENET_MESSAGE_TOO_BIG	SW error	Upgrade to ≥VA2 software.
80231038H	LCOM_TIMEOUT_OF_8344	Net comm failure	If this message is accompanied by another error, check Docking station connections. Otherwise this indicates a SW error and should be reported to Customer service via DataCard.
80231040H	LCOM_UNKNOWN_CONTROL_MSG_ERROR	SIRENET communications error	If this message is accompanied by another error, check Docking station connections. Otherwise this indicates a SW error and should be reported to Customer service via DataCard.
80231048H	EVENT en_q_ring() FULL_QUEUE!	SW Error	Upgrade to ≥VA1.1 software.
80232004H	LCOM_UNEXPECTED_8344_RESET	CPS hardware failure	Reboot monitor and CPS. If problem persists, exchange CPS.
8024a001H	dnldm_process_card_detect unable to get token count	Software memory card has been removed during a download or card has becomre corrupted	Ignore if the memory card was removed during a download. Otherwise, return card.
8025b00dH	Unexpected WRITE_RPL received from child device, hndl = A, owner = B, device state = C	SW Error	Upgrade to ≥VA2 software.
8025b016H	Illegal return code from rcv protocol processor	Script Test message	Ignore.
80264001H	Invalid status after RX_RESET! rx_data=A	Recorder ASIC failed hardware test	Power cycle unit. If error persists, replace Main Processor Board.
80264002H	TX Empty should be set after TX_RESET! tx_data=A	Recorder ASIC failed cold start test	Power cycle unit. If error persists, replace Main Processor Board.
80267003H	MSGM bad state=A	SW Error	Upgrade to ≥VA1.1 software.

Table C-1 Diagnostic Log Codes (Continued)

Code	Description	Cause	Action
8027c007H	status=A	SW Error	Upgrade to ≥VA2 software. Report any future occurrences to Customer service via DataCard.
8027f00eH	No blocks in partition A, handle B	Informational	Ignore.
80283007H	pod sn: A pod status:B	HEMO pod Failure	Replace HEMO pod.
8028a005H	PDMA test failed!Reason: Loopback errors...local> A:0 B:0 dsp> A:2 B:0	DSP hardware,shared memory,clocking in dsp asic	Replace Main Processor Board.
802a1005H	The fans have been turned on high.	Monitor has become overheated. May be caused by clogging of rear vents or by a malfunciton of the fans	Check for blocked vents, malfuctioning fans or room temp over 40C, and that the fans have 5cm clearance. Ingore if all conditions are met.
802a1006H	The ambient and processor temperature delta is out of range.	Monitor has become overheated. May be caused by clogging of rear vents or by a malfunciton of the fans	Check for blocked vents, malfuctioning fans or room temp over 40C, and that the fans have 5cm clearance. Ingore if all conditions are met.
802a1008H	+5V Supply out of tolerance: A V.	Failure on either the Power Conversion Board or CPU board	Isolate problem, and replace defective board
802a1009H	+12V Supply out of tolerance: A V.	Failure on either the Power Conversion Board or CPU board.	Isolate problem, and replace defective board
802a100aH	-12V Supply out of tolerance.	Failure on either the Power Conversion Board or CPU board.	Isolate problem, and replace defective board
802a1012H	The Internal Battery has failed with status: A.	Status of -999 means that the internal battery did not respond to query in time; Status of -1 means that the battery processor has had an error.	Install SW version ≥VA2. If condition persists , report problem to Customer Service via DataCard.
802a1014H	The External Battery has failed.	Battery Broken	Replace Battery
802a1015H	The Battery is incompatible.	Battery not compatible	Try different battery
802a5001H	ERROR: Address: A Written:B Read:D Mask:D (E F)	RAM test failed over TAXI in either CPS or Monitor ; Address of failure given in msg	Isolate problem to CPS or Monitor. If monitor then replace Main Processor Board; If CPS, exchange CPS.
802ab024H	Condition=A	Recorder Hardware Failure	Replace Recorder

Table C-1 Diagnostic Log Codes (Continued)

Code	Description	Cause	Action
802ae010H	CTS not asserted after test power-on	Disconnect during test	Make sure cables don't have any shorts/faults and check for solid connections to the CPS, docking stations and recorder. If all conditions are met, ignore.
802ae011H	Timeout on Readback During Test	Timing disconnect	Make sure cables don't have any shorts/faults and check for solid connections to the CPS, docking stations and recorder. If all conditions are met, ignore.
802b5000H	return_value = A	SW Error	Upgrade to ≥VA1.1 software.
802bd01cH	Powering up the System... Mike: wrong string	Power was turned on.	Ignore.
802bf008H	memory partition 2 is 91 percent used.	Memory utilization note	Ignore
802d4002H	shutdown not due to user. Could be low battery.	Monitor was shut down without using the user's front panel switch. Usually this means that the monitor was running on internal batteries and ran out of power.	If runing monitor on internal battery, ignore this message. Otherwise report condition to customer service
802e701bH	Startup detected Abnormal Shutdown with State: A	SW Error	Upgrade to ≥VA2 software.
802e701cH	Powering up the System...	Power was turned on.	Ignore
802e701dH	new herc version: A boot version: B (same as above ???)	Indicates that new software was installed	No action nessessary
802e701eH	Restart caused by HW Watchdog Timer...	SW Error	Upgrade to ≥VA2 software.
802ef00dH	Mike: why is this one blank ???	SW Error	Upgrade to ≥VA2 software.
802ef011H	trends completely cleared, new sofware loaded	Software warning	Ignore
802f0003H	Mike, what is this description	SW error	Upgrade to ≥VA2 software.
802f2000H	FAILED:taxi_internal_loopback_test! Address:0x0c000000 Data Expected:A Actual:B	Bad CPU board	Replace Main Processor Board
802f2002H	TAXI_GET_SRAM_START_ADDR Invalid psn_id=0x0	Old SC9000 SW being used with new CPS (Olynet)	SC9000 SW needs to be upgraded
802f2003H	TAXI EEROM Contains Invalid Data!c0f0002=A c0f0004=B c0f000c=C c800000=D	EE PROM corrupted	Exchange CPS.
802f2005H	TAXI_SYNC_FAILED! c0f0002=A c0f0004=B c0f000c=C c800000=D	Failure in TAXI link when doing cold start test; more info in error message	Isolate problem; If monitor then replace Main Processor Board; If CPS, exchange CPS.

Table C-1 Diagnostic Log Codes (Continued)

Code	Description	Cause	Action
802f2006H	TAXI_SYNC_FAILED! c0f0002 = A c0f0004 = B c800000 = C	Failure in TAXI link when doing a cold start test; for info in error message.	Isolate the problem. If monitor then replace Main Processor Board; if CPS, exchange CPS.
802f2008H	INTRs didnt fire within 100 usec: c0f0002/4/c=A/B/C c800000=D Fired 0 0 0 0 times	CPU board or link	Check Docking Station connections. Otherwise, exchange CPS.
802f2009H	TAXI EEROM Contains Invalid Data! c0f0002=A c0f0004=B c0f000c=C c800000=D	EEPROM corrupted	Exchange CPS.
802f200aH	TAXI EEROM Contains Invalid Data!	Failure in CPU or connection to CPS	If the next message in the buffer indicates taxi check the docking station connection. Otherwise exchange CPS.
802f200dH	taxi_postmortem:line-3705 c0f0002=A c0f0004=B c0f000c=C c800000=D	CRC failure in taxi link with CPS; more info in error message	Isolate problem. If monitor, replace Main Processor Board; If CPS, exchange CPS.
802f200eH	taxi_postmortem:line-3746 c0f0002=A c0f0004=B c0f000c=C c800000=D	CRC failure in taxi link with CPS; more info in message.	Isolate problem. If monitor, replace Main Processor Board; If CPS, exchange CPS.
802f2011H	LATCH_SIGNAL_OK_ERR:line-4184 c800000=A c0f0004/c/2=A/b/c	TAXI signal quality dropout during transmit; more info in error message	Isolate problem. If monitor, replace Main Processor Board; If CPS, exchange CPS.
802f2012H	FRAME_LOCKED_ERR:line-4270! c800000=A c0f0004/c/2=B/c/d	TAXI signal quality dropout during tranmit; more info in error message.	Isolate problem. If monitor, replace Main Processor Board; If CPS, exchange CPS.
802f2014H	LINK_TIMEOUT_ERR:line-4379 c800000=A c0f0004/c/2=B/c/d	Failure in TAXI link; more info in error message	Isolate problem. If monitor, replace Main Processor Board; If CPS, exchange CPS.
802f2015H	taxi_final_post_mortem_check:line-4126 c0f0002=A c0f0004=B c0f000c=C c800000=D	CRC failure in taxi link with CPS; more info in message.	Isolate problem. If monitor, replace Main Processor Board; If CPS, exchange CPS.
802f2016H	BAD LINK QUALITY DURING STARTUP 3 times! Will Retry! c0f0002/4/c=A/b/c c800000=D	Failure in TAXI link; more info in error message	Isolate problem. If monitor, replace Main Processor Board; If CPS, exchange CPS.
802f201aH	FAILED:taxi_intr_poll_test! addr=A read=B exp=C c800000=D	Failure in TAXI link; more info in error message	Isolate problem. If monitor, replace Main Processor Board; If CPS, exchange CPS.
802f201bH	taxi_postmortem:line-4150 c800000=A c0f0004/c/2=B/c/d	CPS timeout	Exchange CPS and/or replace cable.
80305000H	tigadm_intr : unexpected dev_status in notify	SW error	Upgrade to ≥VA2 software.

Table C-1 Diagnostic Log Codes (Continued)

Code	Description	Cause	Action
8030500dH	b A a=B w=C d=D 0 e=E 0 s=F rx=G ok=H flags=I df=J,K	SW error	Upgrade to ≥VB software. If error persists, replace Main Processor Board.
8030a00aH	time_compare_timestamps failed TS1H=A,TS1L=B, ... TS2H=C,TS2L=D	SW Error	Upgrade to ≥VA2 software.
8030a00cH	ct=A,b, pt=C,d	SW error	Upgrade to ≥VA2 software.
8030a00eH	time_subt_timestamps_ret_offset failed TS1H=A,TS1L=B, ... TS2H=C,TS2L=D	SW Error	Upgrade to ≥VA1.1 software.
8030a021H	time_get_time_stamp_g_wall_time_map failed! GWT (6 parts)= A 24:0:0 DTSH = B, DTSL = D, DWT = E	SW Error	Upgrade to ≥VA2 software.
80323003H	Didn't recv sync event from BKG entity	SW error in VA1.0, more than 24 hours of trend initialized	Upgrade to ≥VA1.1 software.
80323004H	Background Entity didn't Run!	SW Error	Upgrade to ≥VA2 software.
80325001H	Speaker Out of Range value: A	Failed speaker, CPU board or front panel board	If sound is heard replace Front Panel Board. Otherwise, replace Main Processor Board
8033300aH	Unable to fit command=2 (size=A words). 34010	SW Error	Upgrade to ≥VA2 software.
8033b006H	find wvf's band error 0	SW error	Upgrade to ≥VA2 software.
8035900bH	IMRP Shutdown Timed Out!	ROM table on CPS is corrupt	Reinstall the software on CPS
ffffffffH	boot_program_images failed with status: A on image: B	Flash programming error when performing a download	Retry download. If problem persists replace Main Processor Board if downloading monitor SW; exchange CPS if downloading CPS software.

Appendix D

Functional Verification Checklist

4.3 Power Circuits and Startup Functions ________

4.3.1 Power ON/OFF key ________

- Power LED ________
- Piezo tone ________

4.3.2 Power-Up Sequence ________

4.4 Rotary Knob Functions ________

- Pointing Function ________
- Selecting Function ________

4.5 LCD Display ________

- Inoperative pixels within specifications ________
- Backlite illumination ________
- Brightness control ________

4.6 Fixed Keys ________

4.6.1 ON/OFF ________

4.6.2 Main Screen ________

4.6.3 Alarm Silence ________

4.6.4 Alarm Limits ________

4.6.5 All Alarms Off ________

4.6.6 Code ________

4.6.7 Record ________

4.6.8 Cont. Record ________

4.6.9 NBP Start/Stop ________

4.6.10 Zoom ________

4.6.11 Help ________

4.6.12 Mark ________

4.7 ECG/RESP Functions ________

4.7.1 Waveforms/Digital Readouts/Tones ________

4.7.2 Pacer Detection ________

4.7.3 Lead-Off Indicators ________

4.7.4 Alarm Function ________

4.7.5 Asystole ________

4.8 SpO_2 Function ________

4.8.1 Waveforms/Digital Readouts/Tones ________

4.8.2 Pulse Tone Generator ________

4.8.3 SpO_2 Limits Alarms ________

4.9 Temperature Function (MultiMed POD) ________

4.9.1 Digital Readout ________

4.10 Non-Invasive Blood Pressure Function ________

4.10.1 Calibration ________

4.10.2 Hardware Overpressure ________

4.10.3 Pump ________

4.10.4 Interval Mode ________

4.10.5 Safety Timer ________

4.11 $etCO_2$ Function ________

- Sensor Cal. ________
- Sensor Zero ________
- Measured Value w/ Manual Atm. Press. ________
- Measured Value w/ AUTO Atm. Press. ________

4.12 Invasive Blood Pressure Function ________

4.12.1 Monitor Zero Function ________

4.12.2 Monitor IBP 1: HEMO Channel A ________

4.12.3 Monitor IBP 2: ________

4.12.4 Monitor IBP 3: ________

4.12.5 Monitor IBP 4: ________

4.12.6 HEMO POD Channel B ________

4.12.7 HEMO PODChannel C ________

4.12.8 HEMO POD Channel D ________

4.13 HEMO POD Temperature Function ________

4.13.1 IBP 1 ________

- T1a ________
- T1b ________
- $\Delta T1$ ________

4.13.2 IBP 2 ________

- T2a ________
- T2b ________
- $\Delta T2$ ________

4.13.3 IBP 3 _______

- T3a _______
- T3b _______
- ΔT3 _______

4.14 Cardiac Output Function _______

- Blood temperature = 37 ±0.15 C ______
- Injectate temp = 1.0 ±0.25 C ______

4.15 Memory Backup Function _______

4.16 Network Function _______

4.17 R50 Recorder Function _______

4.18 Leakage Current Test _______

- open ground _______
- reversed polarity _______
- openground reversed polarity _______

4.19 Battery Charger Circuit _______

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