Scholar® III
Model 507ELC2
Service Manual

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Copyright

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Warranty

Workmanship & Materials

Criticare Systems, Inc. (CSI), warranties new equipment to be free from defects in workmanship and materials for a period of one (1) year from date of shipment under normal use and service. The 940 Series Multi-Site™ Sensor and the 644 O_2 Sensor carry a six month warranty. CSI's obligation under this warranty is limited to repairing or replacing, at CSI's option, any part which upon CSI's examination proves defective.

EXCEPT AS DESCRIBED IN THE PARAGRAPH ABOVE, CSI MAKES NO WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Exemptions

CSI's obligation or liability under this warranty does not include any transportation or other charges or liability for direct, indirect or consequential damages or delay resulting from the improper use or application of the product or the substitution upon it of parts or accessories not approved by CSI or repair by anyone other than a CSI authorized representative.

This warranty shall not extend to any instrument which has been subjected to misuse, negligence or accident; any instrument from which CSI's original serial number tag or product identification markings have been altered or removed; or any product of any other manufacturer.

Safety, Reliability & Performance

Criticare Systems, Inc., is not responsible for the effects on safety, reliability and performance of the Scholar III 507ELC2 patient monitor if: assembly operations, extensions, readjustments, modifications or repairs are carried out by persons other than those authorized by Criticare Systems, Inc., or

the Scholar III 507ELC2 patient monitor is not used in accordance with the instructions for use, or

the electrical installation of the relevant room does not comply with NFPA 70: National Electric Code or NFPA 99: Standard for Health Care Facilities (Outside the United States, the relevant room must comply with all electrical installation regulations mandated by the local and regional bodies of government).

In Case of Emergency Contact

CRITICARE SYSTEMS, INC.
20925 Crossroads Circle
Waukesha, WI 53186
USA

Telephone: (262) 798-8282
Tech Support: (800) 458-2697
Orders: (800) 458-4615
Fax: (262) 798-8290

Internet: www.csiusa.com

Service Return Policy

Return Procedure

In the event that it becomes necessary to return a unit to Criticare Systems, Inc., the following procedure should be followed:

Obtain return authorization. Contact the CSI Service Department at 800-458-2697 to obtain a Customer Service Authorization (CSA) number. (Outside the US, call 001-262-798-8282.) The CSA number must appear on the outside of the shipping container. Return shipments will not be accepted if the CSA number is not clearly visible. Please provide the model number, serial number, and a brief description of the reason for return.

Freight policy. The customer is responsible for freight charges when equipment is shipped to CSI for service (this includes customs charges).

Loaner service. In the U.S.: If it is necessary to provide a loaner system, CSI will ship a loaner by overnight courier. The loaner system must be returned to CSI at the customer's expense within one week after receipt of the repaired goods. If the unit is not returned to CSI within that time, the customer will be invoiced for the full purchase price of the equipment.

Outside the U.S.: No loaners are available from CSI internationally. Contact your local CSI representative.

Incoming Inspection

The following incoming inspection is required whether it is a first time arrival or a return from service. Prior to clinical use, inspect the instrument for the following.

1. The quality inspection seal on the instrument should be unbroken. This seal indicates that the instrument has been tested according to manufacturers specifications.
2. No physical damage is observed.
3. The instrument's battery is to be charged by connecting the instrument to a power outlet for a minimum of 6 hours prior to clinical use.
4. When connecting the instrument to a power outlet and then turning the instrument on, all displays appear to function correctly and no system errors occur.

If a discrepancy to these inspection items is observed, do not use the instrument and immediately report the discrepancy to the CSI Service Department.

EC Declaration of Conformity

Scholar III 507ELC2 Patient Monitor

To view the Declaration of Conformity, visit the Criticare website at www.csiusa.com. A copy of the Declaration can also be faxed. Contact Criticare's customer service department at (262) 798-8282 to obtain a faxed copy of the Declaration.

Representative in the European Union

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Section 1 — Introduction

Description

The Scholar III model 507ELC2 series patient monitors interpret and display real time physiological data including waveforms and numerical data. The monitor is designed for multi-parameter measurements, including ECG, NIBP, SpO_2, temperature and respiration. For all these vital parameters, the 507ELC2 monitor has limit alarms and alerts. The model 507ELC2 series comes equiped with a TFT color display. The 507ELC2 monitor also prints strip chart recordings and stores tabular trends for review. The 507ELC2-EX does not have print capabilities.

NOTE: All illustrations in this manual are of the Model 507ELC2.

Intended Use

The 507ELC2 series monitor is intended to monitor physiological parameters of patients within clinical care settings. It is intended that the user is a professional health care provider. Physiological data, system alarms, and patient data analysis are available to the care provider from the monitor.

The user is responsible for the interpretation of the monitored data that is made available. Physiological data should be reviewed by a qualified clinical personnel prior to any medical intervention.

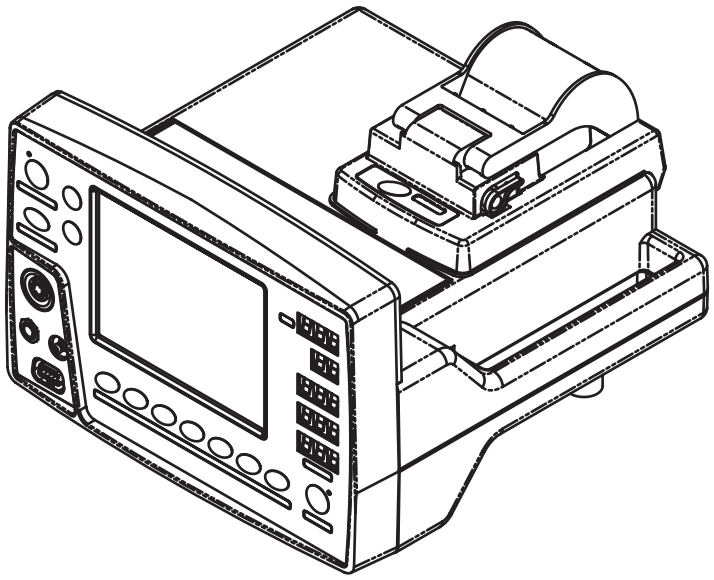


Figure 1-1: Model 507ELC2 Vital Signs Monitor

Pulse Oximetry Measurement (SpO_2)

The monitor uses Digital Oximetry (DOX™) technology to measure blood oxygen saturation (SpO_2).

Definition

Hemoglobin exists in the blood in several forms:

- Oxygenated (Oxyhemoglobin)
- Reduced (Deoxyhemoglobin)
- Dyshemoglobins (carboxyhemoglobin and methemoglobin.)

In the monitor, SpO_2 (pulse arterial oxygen saturation) is the ratio of oxygenated hemoglobin to the sum of oxygenated hemoglobin plus hemoglobin which is available for binding to oxygen, as expressed in the following formula:

$$\text{percent oxygen saturation} = \frac{\text{oxyhemoglobin}}{\text{oxyhemoglobin} + \text{deoxyhemoglobin}} \times 100$$

Dyshemoglobins, such as carboxyhemoglobin and methemoglobin, are not directly measured and therefore are not factored into the measurement.

DOX™ Digital Oximetry

The monitor does not use analog circuitry for signal processing. Digital signal processing in the microprocessor results in lower noise from circuitry components, resulting in a cleaner signal and better performance under low perfusion conditions. There is also improved rejection of noise from the patient and environment, due to the availability of the “true,” unfiltered sensor signal for digital signal processing.

Method

The digital pulse oximeter measures oxygen saturation and pulse rate using the principles of spectrophotometry and plethysmography. The sensor is completely non-invasive, and there is no heat source that could burn the patient.

The pulse oximeter sensor contains two types of LEDs; each type emits a specific wavelength of light. Since oxygenated hemoglobin and deoxygenated hemoglobin absorb light selectively and predictably, the amounts of these two compounds can be determined by measuring the intensity of each wavelength that passes through the measuring site.

The light from the LEDs shines into a pulsating vascular bed. A photodetector located opposite or alongside the LEDs measures the intensity of each wavelength transmitted through the monitoring site. The light intensity is converted to an electrical signal, which is input to the monitor. The effects of skin pigmentation, venous blood, and other tissue constituents are eliminated by separating out the pulsating absorption data.

SpO_2 Clinical Testing and Accuracy

All Criticare oximeters (DOX™ compatible) have SpO_2 calibration tables which were originally generated by monitoring desaturated human patients or volunteers and matching their displayed SpO_2 value to the value determined by sampling arterial blood and measuring functional SaO_2 with a clinical laboratory grade multi wavelength optical oximeter (i.e. CO-oximeter). The final SpO_2 calibration curve was then generated based upon numerous patients' data over the range of 40 to 99% SaO_2. All accepted data were taken from patients with dyshemoglobin (i.e., carboxyhemoglobin, methemoglobin) concentrations near zero.

This oximeter is a two-wavelength device, which is calibrated to measure functional SpO_2 only when dyshemoglobin concentrations are near zero. The accuracy specifications of this device will not be met with high concentrations of dyshemoglobins. Significant concentrations of carboxyhemoglobin will result in a higher displayed SpO_2 value than is actually present in the patient.

Heart Rate

The heart rate is determined primarily from the ECG waveform data. A beat detection algorithm is used to identify QRS beats.

The monitor has a user selectable smart heart rate function. It will automatically use alternate sources to determine heart rate, if the primary source becomes unmeasurable. The plethysmograph (SpO_2 waveform) is used if the ECG heart rate is unavailable. In the absence of SpO_2 and ECG data, the NIBP oscillometric data is the final default source for a heart rate measurement.

NOTE: The accurracy of the heart rate depends upon the source. The range of the measurable NIBP based heart rate will not extend as far as the range available in other modules used by the smart heart rate feature.

NOTE: The NIBP based heart rate is not a continuous measurement and is only current during an NIBP measurement.

ECG Measurement

The electrocardiogram (ECG or EKG) records the changing potential generated by electrical activity of the heart.

Method

To obtain an overall view of the heart's electrical activity three electrodes are attached to lead wires detecting electrical impulses from the patient's heart to the skin. The monitor calculates the difference in electrical force between two electrode sites. Electrode polarity (positive, negative, or ground) depends on the cable receptacle the lead wire is attached to and the lead selected on the monitor screen.

The ECG design uses the standard (conventional bipolar limb leads) leads I, II, III using a 3-lead cable accessory.

Stability of Accuracy

The monitor is equipped with pacemaker detection and user selectable pacer rejection. There are no known safety hazard due to the operation of a cardiac pacemaker or other electrical stimulators when used with this patient monitor.

The accuracy of the monitor is not affected by arrhythmia or other physiological conditions where the electrocardiogram amplitude and heart rate are within the detectable limits specified for the monitor. The monitor has user selectable signal filtering in the 60 Hz and 50 Hz bands that reduce electrical interference from the AC (mains) power sources. User selectable filters are also available.

Respiration

Respiration can be measured via the ECG electrodes.

When determining respiration from the ECG, the monitor measures patient respiration by impedance pneumography. As the patient's chest changes size and shape during inspiration and expiration, the resistance between two chest (or abdomen) ECG electrodes changes. Respiration rate is calculated from this change in resistance. The monitor uses ECG data from lead I for the impedance measurement.

Non-Invasive Blood Pressure (NIBP)

The monitor uses ComfortCuff™ technology to determine non-invasive blood pressure by means of oscillometry. The oscillometric method detects volume displacements within the artery and senses pressure variations within the blood pressure cuff during inflation. The monitor uses cuffs ranging in size from neonate cuffs to thigh cuffs.

Comfort Cuff™ Technology

ComfortCuff technology measures NIBP while the cuff inflates. Consequently, a measurement is obtained more quickly and with less discomfort than with monitors, which measure NIBP during cuff deflation.

Description of NIBP Measurement

The NIBP cuff begins to inflate at the beginning of the NIBP measurement cycle. As the cuff pressure approaches the diastolic pressure of the patient, the cuff pressure waveform begins to indicate the pulse waveform. The cuff pressure at this point is equal to the patient's diastolic pressure, which is stored by the monitor.

As cuff pressure continues to increase, the pulse waveform (as measured from BP cuff pressure fluctuation) becomes stronger, reaching its maximum at the patient's mean arterial pressure (i.e., when cuff pressure = mean BP). The monitor stores this value as mean pressure.

As cuff pressure increases further, it approaches the patient's systolic pressure, and the cuffs pulse waveform decreases in amplitude. The cuff pulse waveform disappears at the point where cuff pressure is equal to the patient’s systolic pressure.

When the monitor determines that the cuff waveform has decreased to zero amplitude, it stores the cuff pressure value as the systolic pressure, and releases the pressure from the cuff. This typically occurs at about 10 mmHg over the patient's systolic pressure. The cuff then rapidly deflates.

NIBP Clinical Testing and Accuracy

This device was clinically tested per the requirements of AAMI SP-10 and is compliant with EN1060. The NIBP module as installed in the 507ELC2 monitor has been tested to meet the performace specifications listed in this manual.

Cuff Inflation and Pressure Protection

The maximum cuff inflation rate is 15 mmHg/sec. The software limits inflation to 300 mmHg adult or 150 neonate. A secondary circuit limits maximum possible cuff pressure to 316 mmHg. Cuff pressure is allowed to remain above 30 mmHg for a maximum of two minutes.

The monitor automatically deflates the cuff if the time limit is violated. The monitor contains hardware protection for overpressure conditions, pressure transducer failures, or microprocessor and pump control circuit failures.

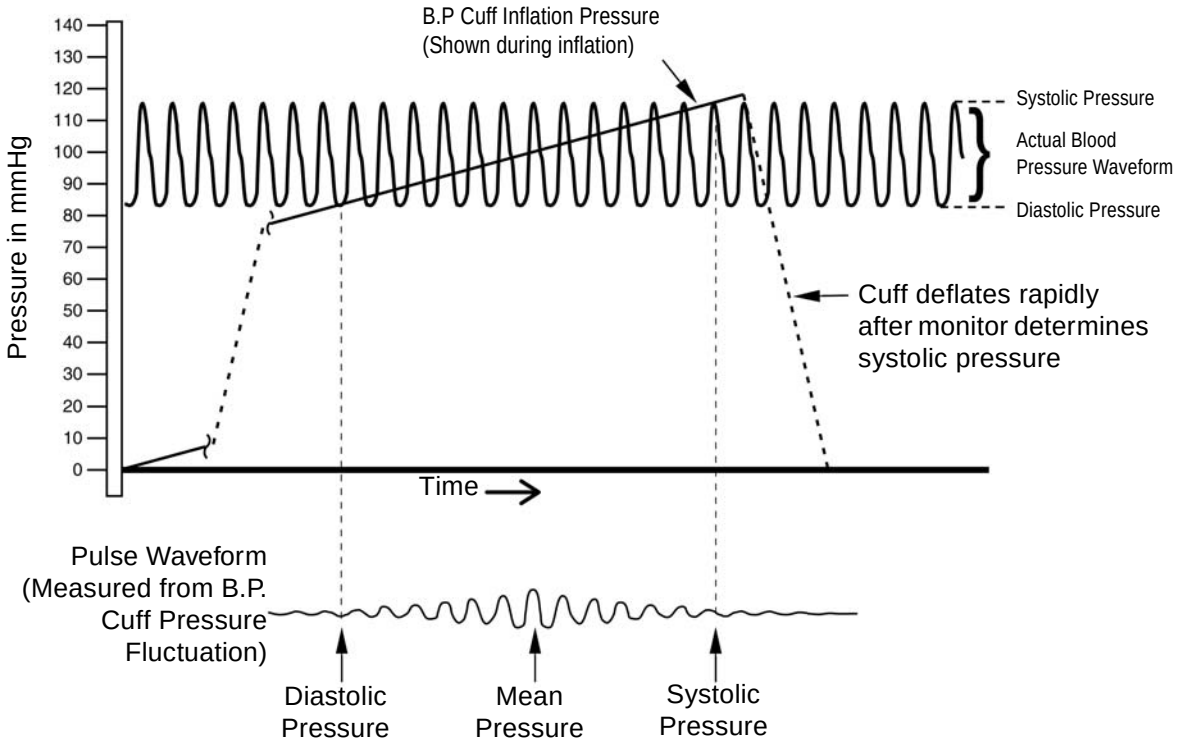


Figure 1-2: NIBP Cuff Pressure and Pulse over Time

Temperature Measurement

Body temperature is measured by the monitor using a thermistor (temperature sensing elements in the temperature probe). The thermistor can sense change in body temperature by changing electrical resistance.

- Unusual, fast artificial variations in temperature readings may occur with accompanying applications of an electrocautery system.
- Electrical leakage current of the cable when used with the monitor and sensor comply with IEC 601-1/EN 60601-1.

The monitor is compatible with any YSI-400 series temperature probe.

Specifications

ECG

Connector:	Standard AAMI
Lead Selection:	3-Lead; I, II, III
Frequency Response:	Filter Off; 0.05 - 100 Hz Filter On; 0.50 - 40 Hz
Sweep Speed:	25, 50 mm/sec
Electrosurgery Protection:	Yes
Defibrillator Protection:	Yes
Pacer Rejection:	Yes

SpO_2

Range:	1-99%
Resolution:	1%
Accuracy:	70-99% range; ± 2%; 50-69% range; ± 3% <50%; unspecified; Statistical, represents one st. dev. (~66%) of clinical samples.
Indications	Plethysmograph, Numerical, Audible (pulse tone pitch varies with SpO_2)
Method:	Dual wavelength LED
Modes:	Adult/Neonate
Operation:	Continuous Use
Sensor Wavelength:	660nm/905nm
Sensor Power:	<80mW

Heart Rate

Source:	Smart Switching, Selectable; ECG(primary), Pleth, NIBP,
Range:	30-300 bpm(ECG, Pleth) 30-240 bpm (NIBP)
Accuracy:	± 1 bpm or 1%
Pulse Tone:	Selectable, On/Off

Respiration

Source:	Impedance ECG
Rate Range:	9 to 150 breaths/minute
Resolution:	1 breath/minute
Accuracy:	> of ± 1% or ± 1 breath/minute

NIBP

Technique:	Oscillometric measure upon inflation
Measurement Time:	<40 seconds average; standard adult cuff
Automatic Measurement Cycles:	1, 2, 3, 5, 10, 15, 30, 45, 60 min; 2, 4 hrs
Inflation Pressure Range:	Adult; 0 to 300 mmHg Neonatal; 0 to 150 mmHg
Resolution:	1 mmHg
Accuracy:	± 2 mmHg or 2% of reading
STAT mode:	5 min of consecutive readings

Temperature

Range:	68° to 113°F, 20° to 45°C
Accuracy:	± 0.1°C
Probe Type:	YSI-400

Alarms

Characteristics:	EN 475, Adjustable
Indication:	Audible; Visual
Levels:	High, Medium, Low, Informational
Alarm Modes:	Adult/Neonate, High and low limit settings for each mode.
Volume:	User Adjustable (1-10)
Silence:	Yes; 2 minutes or permanent

Trend Reports

Types:	Tabular
Trend memory:	24 hours
Tabular Intervals:	1 , 2, 5, 10, 15, 30, 60 minutes, 2, 4 hours
Data Types:	HR, SpO_2, Temp., Resp., NIBP (Systolic, Diastolic, Mean)

Recorder (507ELC2 only)

Recorder Type:	Internal thermal line printer
Data Formats:	Single or dual waveform; Tabular
Paper Speed:	25mm/sec (fixed) Tabular printing; 25 or 50 mm/sec (selectable) Waveform recording, fixed-length or continuous.

Controls

Screen:	5.9" passive LCD or active color TFT, (121mm × 91mm)
Resolution:	320 x 240 pixels
Wave Slots:	3 (maximum waveforms 2)
Waveform Display Gain:	0.5×, 1×, 2×, 4× user selectable
Waveform Sweep Speed:	25 or 50 mm/sec, selectable
Keys:	11; membrane-activated
Languages:	English

System Outputs

Communication Port:	RS 232-compatible; digital DB-9
Defibrillation Sync:	BNC connector (analog output ±1V range)

Mechanical/Electrical

Weight:	8.5 lb; 3.83 kg
Size:	7.6" (H) x 10.1" (W) x 10.7" (D) 19cm (H) x 26 cm (W) x 27cm (D)
Voltage (external power supply):	90 to 260 VAC; 47 to 63 Hz
Voltage (monitor):	16V DC
Battery:	Sealed lead acid
Battery Life:	1 hour, typical
Recharge time:	6 hours

Environmental

Operating Temperature:	59° - 104°F, 15° - 40°C
Storage Temperature:	23° - 122°F, -5° - 50°C
Operating and Storage Humidity:	15% to 90%; non-condensing
Type of Protection:	Class I Equipment
Degree of Protection:	Type CF, Defibrillator-Proof
Protection against ingress:	IPX1, drip-proof equipment

All specifications are subject to change without notice.

Symbols

Symbol	Definition
	Refer to Operator's Manual for Information
CE 0413	European Community Mark
	Electrical Testing Laboratories (ETL) Mark
	Not For Use with Flammable Anesthetic Gasses
	Do not dispose of in municipal waste. Wheeled bin symbol indicates separate collection for electrical and electronic equipment. (WEEE Directive 2002/96/EEC)
	Type CF Equipment, defib proof
	Shock Hazard
	Technical Support Phone Number
	Non-Invasive Blood Pressure
	Temperature Monitoring
	Not a Sensor Connection

Definitions for Warning and Caution symbols:

⚠WARNING⚠ Designates a possible dangerous situation. Non-observance may lead to death or the most severe injuries.

⚠CAUTION⚠ Designates a possible dangerous situation. Non-observance may lead to minor injuries or damage to the product.

Safety

⚠WARNING⚠

- Read this manual entirely before attempting clinical use of the monitor.
- A possible explosion hazard exists! Do not use the monitor in the presence of flammable anesthetics.
- Cables, cords, and leadwires may present a risk of entanglement or strangulation! Verify safe and proper positioning of these items after patient application.
- Unapproved modifications to the monitor may cause unexpected results and present a hazard to the patient.
- Risk of electrical shock! Do not remove cover. Refer servicing to qualified personnel.
- U.S. Federal law restricts this device to sale by or on the order of a physician.

⚠CAUTION⚠

- Use the monitor only with recommended accessories! Use of unapproved accessories may cause inaccurate readings.
- Equipment accuracy may be affected at extreme temperatures.
- Do not store equipment at extreme temperature. Temperatures exceeding specified storage temperatures could damage the system.
- Do not press on the keys with surgical instruments or other tools. Sharp or hard objects could damage the keys. Use only your fingertips to press on the keys.
- Changes or modifications not expressly approved by Criticare Systems, Inc., may void the user's authority to operate the equipment and may also void the warranty.

Leakage Current

The monitor complies with leakage current limits required by medical safety standards for patient-connected devices. Conforms to EN 60601-1. A hazard caused by the summation of leakage currents is possible, when several pieces of equipment are interconnected.

Voltage Fluctuations

When operated in the line voltage range specified in this manual any fluctuation will have a negligible effect. Very low line voltage will cause the monitor to revert to battery power. Very high line voltage may cause damage to the charger circuits. The monitor is designed with circuitry that will turn the unit off before spurious readings can be caused by a low battery condition.

Software Error Related Hazard Mediation

Criticare Systems, Inc., has quality control practices and procedures in place to review potential hazards as they relate to software. The monitor is Year 2001 Compliant and utilizes a two-digit year for all date, time, and leap year calculations.

Potential Interference

This device has been successfully tested to IEC 60601-1-2 specified levels for emissions of and resistance to electromagnetic energy fields. External disturbances which exceed these levels may cause operational issues with this device. Other devices which are sensitive to a lower level of emissions than those allowed by IEC 60601-1-2 may experience operational issues when used in proximity to this device.

MAGNETIC FIELDS

Use of the monitor in an MRI environment may interfere with MRI image quality. Use of MRI may interfere with the monitor.

RADIO FREQUENCY INTERFERENCE

The monitor conforms with IEC 61000-4-3 for radio frequency interference, and will operate with negligible adverse effects.

CONDUCTED TRANSIENTS

The monitor conforms with IEC 61000-4-4, and IEC 61000-4-5 for conducted transients, and will operate with negligible adverse effects.

X-RAY

The monitor will operate with negligible adverse effects in an x-ray environment. However, the monitor should not be placed directly in the x-ray beam, which could damage the internal electronics of the monitor.

OTHER INTERFERENCE

There is a negligible adverse effect to the monitor from electrocautery and electrosurgery, infrared energy, and defibrillation.

Use of Anesthetics

Do not use this device in conjunction with flammable anesthetics such as cyclopropane and ether. The monitor can sample from pure oxygen environments, but the monitor itself should never be placed inside an oxygen tent or gas containment apparatus. Proper anesthetic gas waste recovery should be used.

Biocompatibility

All patient-contact or user-contact materials in this monitor and it's accessories have passed ISO 10993-5, -10, & -11 biocompatibility tests or have been in use in clinical environments in large numbers over an extended period of time predating these standards.

Latex Content

All Criticare Systems, Inc., products, including patient monitors and accessories, are free from latex in any location that may result in patient contact.

Section 2 — Service Interface

Service Mode

⚠WARNING⚠

- Never service a monitor while it is attached to a patient.
- Never enter the service menu while monitoring a patient.

Self Tests

To verify the built-in self tests:

1. Press the ON/OFF key and the DOWN ARROW key of the monitor at the same time. The monitor displays the message:

   CHECKING FOR SERVICE TOOLS . . .

   If no communications cable is attached the monitor should continue to the self tests. The following message displays:

   SELECT A TEST . . .

2. The software revision and the serial number display on the monitor. Verify that the serial number is the same as the name plate on the bottom of the monitor.
3. Press the DISPLAY key. Observe that the LEDs display an *8* on all 14-segment LEDs, then *0* and count to *9*. Make sure that all the proper numbers display.
4. Press the PRINT key. The monitor should print a full character set and four lines of test bars.

System Checks

Verify the general settings of the monitor.

1. Restart the monitor. Press the ON/OFF key while holding the SETUP key. Confirm that the background of the LCD display illuminates a bright green color when the monitor turns on. The message *CONFIG TO DEFAULT* should appear.
2. Enter the second *Setup* menu. Set the correct *TIME* and *DATE*.
3. Confirm that the line frequency (*LINE FREQ:*) is set correctly. The value should be set to 60 in the United States.

Section 3 — Theory of Operation

General

The Scholar III consists of a single main processor supporting all technologies except NIBP. The software design supports this hardware philosophy by employing an RTOS to simplify prioritization of the many functions resident on the main processor.

Main Board

The Main Board incorporates the system microprocessor, memory, and peripherals, as well as the pulse oximetry circuitry and power management functions. Most system functions are controlled by software running on the microprocessor.

Microprocessor Circuitry

The microprocessor circuitry handles the Main Board computational functions. It also provides integrated I/O functions, including timers, I/O pins, and two serial interfaces.

SERIAL INTERFACES

The Scholar III incorporates two mark-high logic-level asynchronous serial communications interfaces.

Power Management/ Watchdog Circuit

The power management/watchdog circuit provides a power fail and/or low battery level detection mechanism, manual reset input, and a hardware-based check on software operation. The watchdog resets the Main Board, and hence the entire system, if the main processor software fails to clear it within a certain time interval.

LCD Controller

This circuit interfaces the main processor with the graphics LCD display on the front panel and the display memory.

The greeting screen is painted as a form of functional test of the LCD display. Messages on the screen indicate power-on operations which are available, and which have been selected.

LED Drivers

The LED drivers control the multi-segment, multi-digit LEDs used for display of certain vital signs data. The ability to blink individual LED elements is provided in software. The blinking of all display elements is synchronized.

LEDs provide data on heart rate (BPM), systolic blood pressure (SYS mmHg), diastolic blood pressure (DIA mmHg), and Mean blood pressure with red LEDs and SpO_2 with green LEDs.

Keypad Interface

A matrix keypad interface connects the front panel display controls to the Main Board. There are four column drive outputs and three row sense inputs.

NIBP Module Interface

The NIBP technology module is controlled from the microprocessor through a logic-level serial interface. The microprocessor has a POWER ON control line which, when asserted, switches on power to the NIBP module. This line is inactive at power-up and asserted by the initialization software which permits a staged powerup of this major system component.

External RS-232 Serial Data Port

The Scholar III provides one patient-isolated external RS-232 serial data port (TX, RX, and ground). This is compatible with Central Station and ASCII printer applications.

RF MODEM SUPPORT

For wireless Central Station applications, the interface must be capable of powering an external RF modem (+5VDC, 100 mA maximum).

Analog Output Interface

The Scholar III has one patient-isolated external analog output. This will provide a 1 v output capable of driving a high-level input, such as a defibrillator or chart recorder. The microprocessor includes a PWM timer to generate the analog signal.

Internal Recorder

The model 507ELC2 contains an internal recorder as standard equipment; the 507ELC2-EX does not have an internal printer. This recorder contains of a single stepper motor for paper movement while the formation of text and graphs is accomplished through a line of 384 thermal dots. This design permits higher recording speed.

Because of the enhanced recording capability, the 507ELC2 provides real-time graphical waveform recording at either 25 or 50 mm/sec. Tabular printing (demand or interval) is always at 25 mm/sec.

The internal printer control consists of three components:

- Initialization,
- A rasterizing print engine, and
- A print driver in the interrupt service routine.

The functions are inactive if the printer is not installed; this is determined during initialization. The functional interface of the PRINT_TASK activates the rasterizing of text and graphics and controls the print driver.

Speaker Control

The speaker drive circuit is a DAC controlling speaker volume, and an output pin to control frequency. The speaker is driven by a square-wave signal generated by a software-controlled timer; hence, any drive frequency has harmonic components and no “pure tones” are generated. This reduces the risk of an alarm being missed by an individual with a “notch” hearing deficit.

Power Management

This circuit:

- Monitors power sources and utilization,
- Informs the main processor of an impending power outage, and
- Permits the shutdown of selected sub-systems to reduce power consumption when line power is not available.

Software Design: Main Board

The Scholar III Main Board software is a collection of initialization routines, interrupt service routines, drivers, and RTOS tasks. The interrupt service routines communicate directly with the RTOS by signaling events, and indirectly by filling circular data buffers to be consumed by RTOS tasks.

In “C” programming, the following suffixes are used:

_SVC	an interrupt service routine
_TASK	an RTOS task number
_MAIL	an RTOS mailbox number
_TIMER	an RTOS timer
_EVENT	an RTOS event number
_RESOURCE	an RTOS resource number

The software design description is organized as follows:

- Data elements, including key data structures; initialization and reset self-test code;
- Interrupt service routines (ISRs);
- Drivers; and
- Tasks.

System Drivers

System drivers are low-level, non-ISR functions primarily responsible for hardware interfacing.

LCD DISPLAY DRIVER
This driver communicates to the LCD controller in a synchronized fashion to perform graphics plane and text plane updates without undesirable side effects.

LCD CONTRAST DRIVER
This driver interacts with digital potentiometer circuitry to provide LCD contrast initialization and adjustment via software.

WATCHDOG DRIVER
The watchdog timer must be periodically cleared to prevent a system reset from taking place. Since the Main Board software is built around an RTOS, it is desirable to make the watchdog clear logic dependent upon recognition of proper operation of several execution paths.

REAL-TIME CLOCK (RTC) DRIVER

The real-time clock (RTC) circuit is a battery-backed source of date and time-of-day information independent of the microprocessor. The RTC driver provides for reading the RTC contents, testing date and time integrity, updating the RTC, and managing the RTC alarm event interrupt. In the Scholar III, this interrupt is employed as an independent time-base check.

ANALOG OUTPUT DRIVER

The analog output is a patient-isolated external output signal programmed through a PWM timer to reproduce a selected waveform. The functional interface to the analog output update function consists of init_analog_out(), set_mode_wave() and update_analog_wave(). The PWM hardware is initialized by the init_analog_out() routine. Analog output signal selection is controlled through the set_mode_wave() function. The dynamic analog output update is accomplished via the update_analog_wave() function, called 300/sec from the system timer service ISR, which also scales and stores signal data for analog output directly into the wave[] global array.

The analog output waveform is reproduced with 100 Hz bandwidth. Simulated pacer pulses are omitted from the analog reproduction of the ECG signal.

External Service Tools

Upon activating the service mode at power-up the monitor attempts to locate any service tool attached to the external serial port. If it locates a service tool, the Scholar III is under control of the service tool, permitting execution of diagnostic or software upgrades.

Main Board Software Upgrade

The initial software installation, and all subsequent software upgrades is in flash memory and is downloaded through the external serial port. The monitor shall not perform patient monitoring during software downloads. Initiate the Main Board software installation operation by holding the DOWN arrow key while you apply power to the unit. The software installation screen appears with the message *"SERVICE TOOL IN PROGRESS..."*.

NIBP Module Software Upgrade

Upgrade the NIBP module through the external serial port. The monitor shall not perform patient monitoring during software downloads. The NIBP module software installation operation is initiated by holding the NIBP START/STAT/STOP key while you apply power to the unit. The software installation screen appears with the message *"NIBP SERVICE TOOL IN PROGRESS..."*.

NIBP Module Service Tool

The NIBP module Service tool permits execution of the inflation/deflation speed test, leakage test, calibration, and safety checks through a program running on an attached PC. The software installation screen appears with the message *"NIBP SERVICE TOOL IN PROGRESS..."*.

Power Supply

A universal switching power supply simplifies operation in international markets.

The power supply is an external universal switching power supply. It provides 1.6 A at 16 VDC. The LCD display requires a negative power source (typically -24 V) which is supplied by an inverter on the main board. The power supply satisfies international operational requirements by functioning with either 90-260 VAC at 47-63 Hz line frequency. The power supply is fused inside the monitor.

The battery is a rechargeable lead-acid in a compartment accessible for replacement without opening the main chassis. It has a maximum capacity of 2.0 Amp-hours.

In order to monitor the status of the line power, and condition of the battery pack, the internal power supply circuitry drives several status lines available to the main module. The power management/ watchdog circuit provides a low battery level detection mechanism, manual reset input, and a hardware-based check on software operation (watchdog timer).

ECG

The ECG module uses a differential amplifier to extract surface ECG activity from a pair of electrodes. Input to the amplifier is protected against damage from excessive voltages. Passive filtering is used to reduce high power RF interference from electrosurgical devices. Filtering for monitor vs diagnostic modes, lead selection, lead off detection, and pacer pulse detection are performed in hardware, under software control. Gain control, notch filtering to remove line frequency interference, pacer artifact handling, noise detection, beat detection, heart rate calculation, and serial communications are performed in software.

Non-Invasive Blood Pressure

The Criticare NIBP module is an oscillometric, continuous-ramping, inflate-mode design, with a single-lumen hose for both pressurization and sensing. The general principles of oscillometric NIBP are well-described in “Handbook of Blood Pressure Measurement” (Geddes). However, the inflate-mode design of the Criticare NIBP module distinguishes it somewhat from the systems described in Geddes’ book.

SpO_2 Board

The SpO_2 is measured using Criticare’s DOX™ digital oximetry. This circuit design is proprietary to Criticare Systems, Inc., and therefore is not described here.

Temperature

The temperature probe produces a resistive change in response to temperature which is inversely related to temperature in an approximately exponential fashion. A precision calibration resistor is used auto-calibrate the circuitry. Linearization and conversion to temperature units is performed in software via table translation. The temperature facility is a circuit on the ECG board.

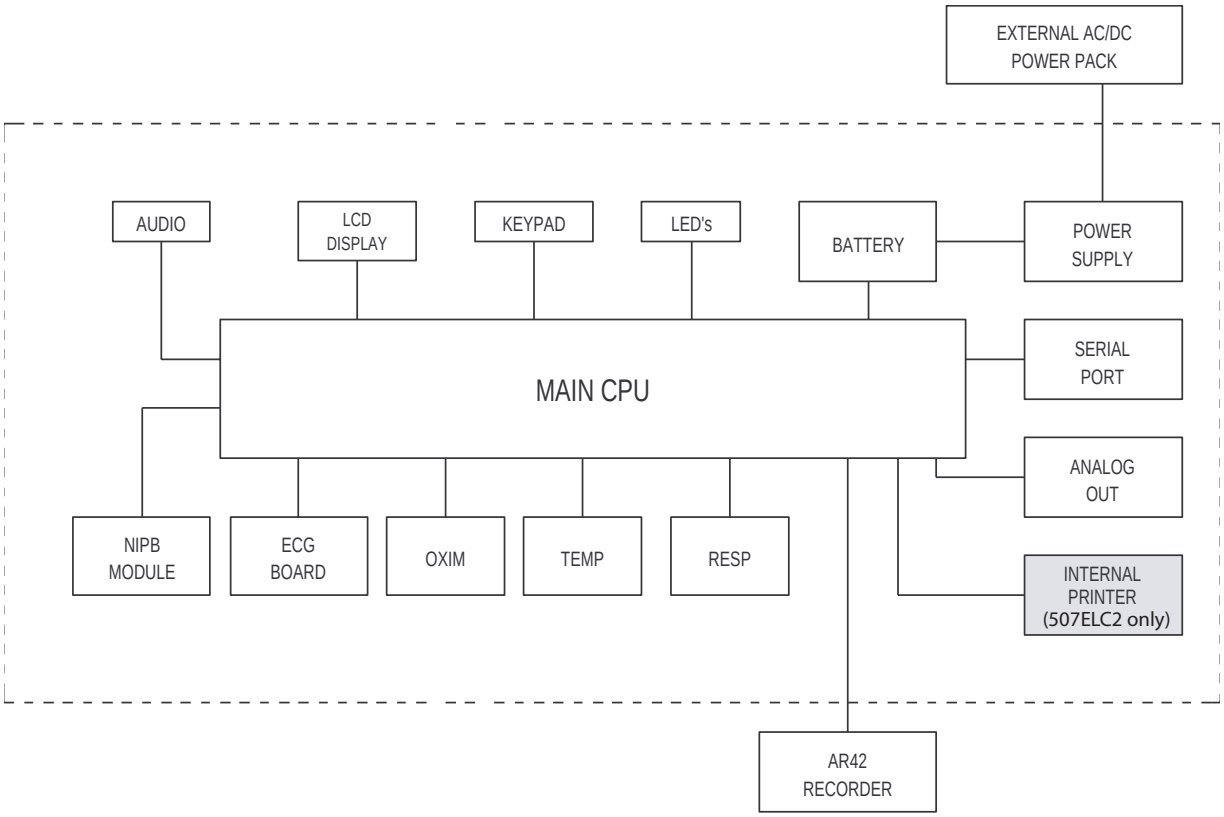
Impedance Respiration

The TTI respiration circuit uses a transformer to generate a low-current, high frequency stimulus through the Lead I electrodes. The resulting voltage variations reflect impedance variations across the thorax, which in turn reflect respiration activity (as well as other phenomena including cardiogenic artifact and motion artifact).

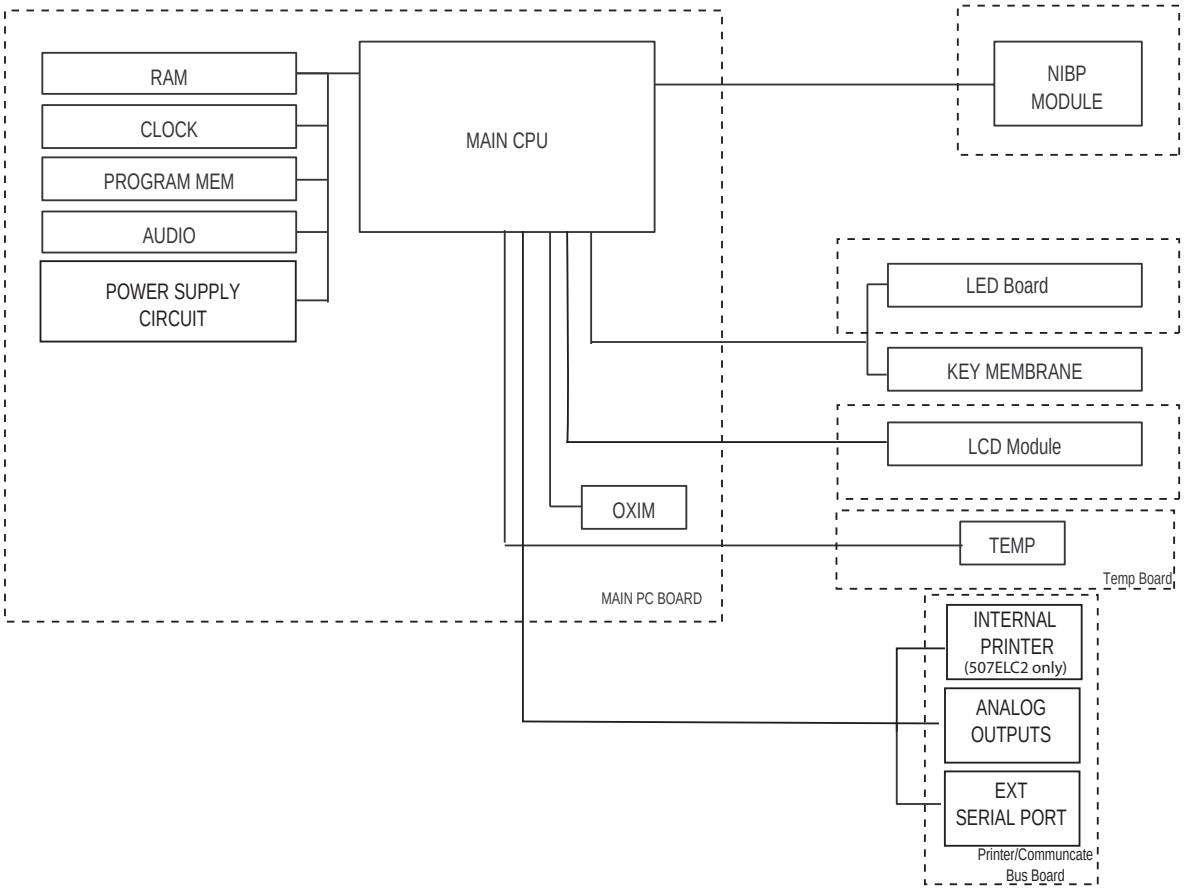
Block Diagrams

The following pages contain the block diagrams for the Scholar III 507ELC2 patient monitor.

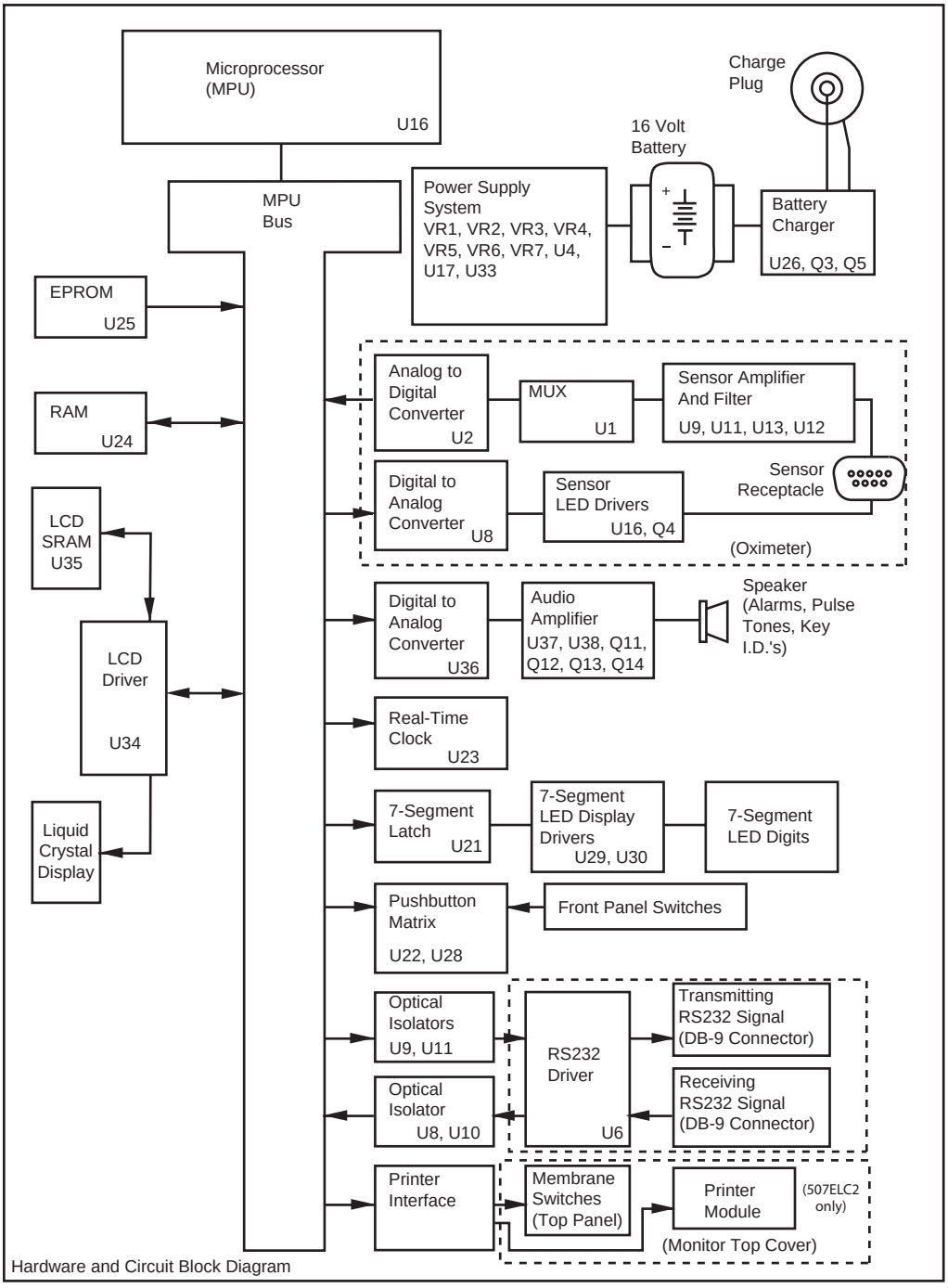
System Level Block Diagram



Hardware Block Diagram

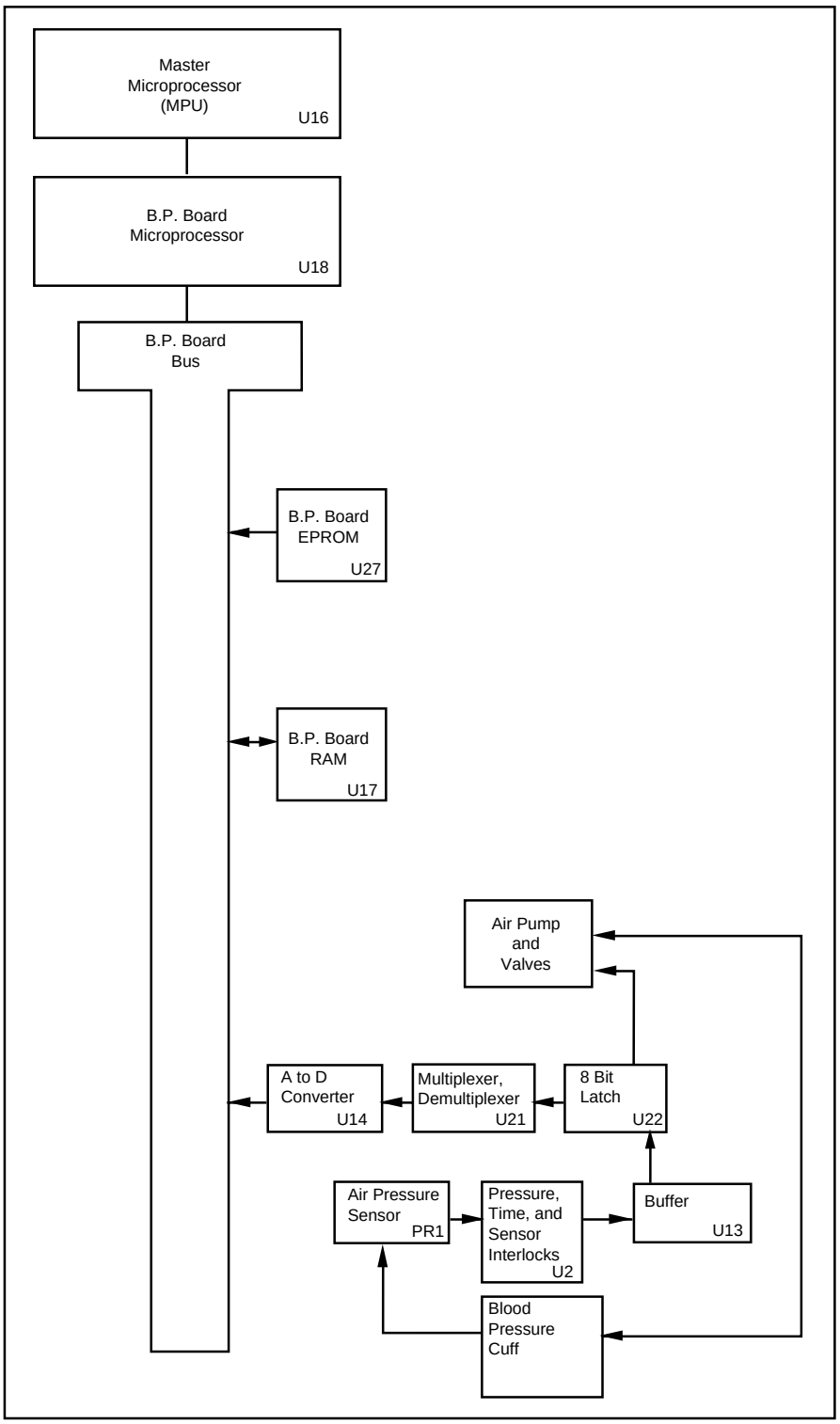


Main Board, Display Board, and SpO_2 Board Circuit Diagram

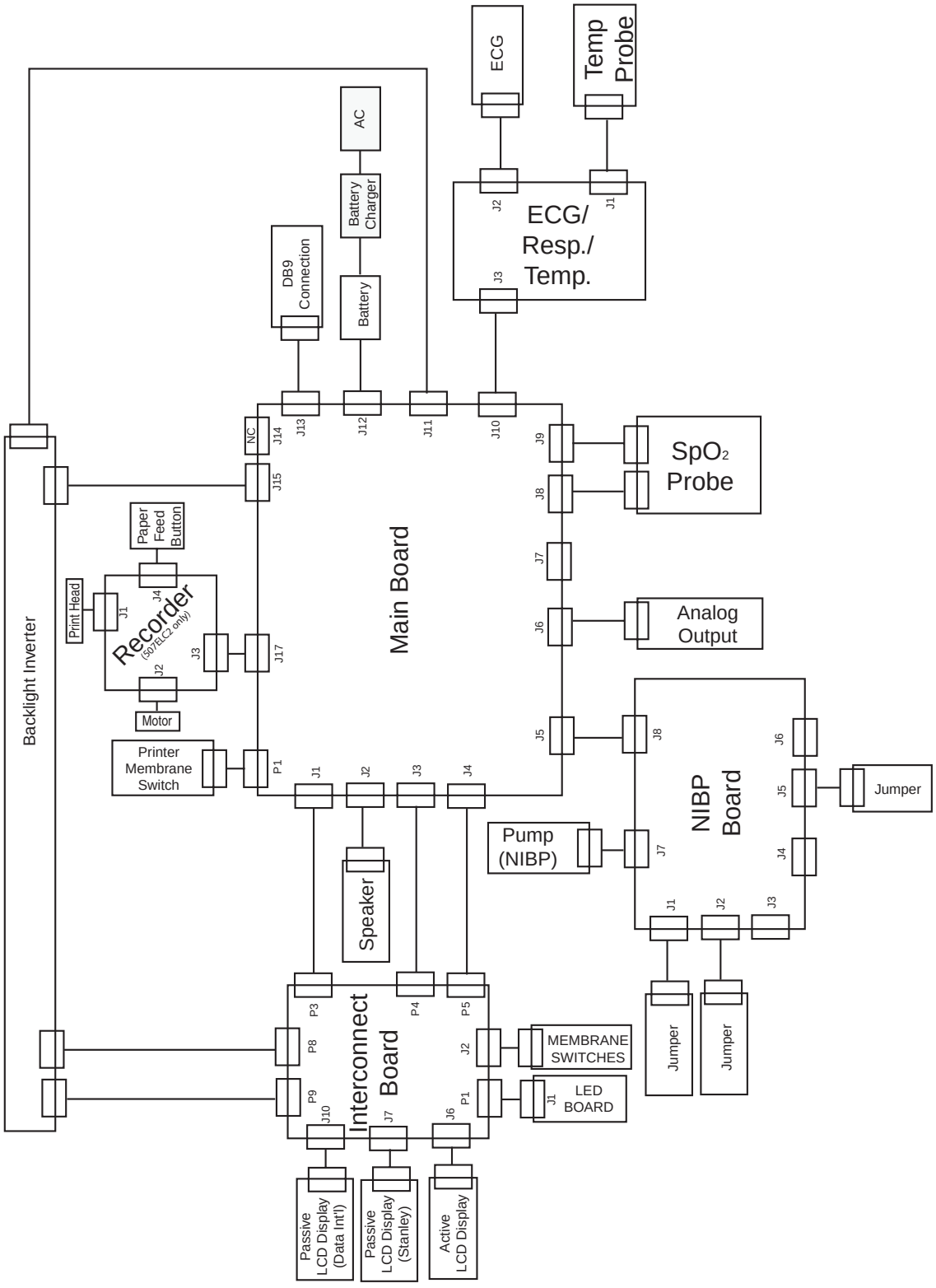


Hardware and Circuit Block Diagram

Blood Pressure Board Circuit Diagram



Block Diagram



Section 4 — Cleaning and Disinfecting

Cleaning and Disinfecting

⚠WARNING⚠

- Shock Hazard! Turn the power off and disconnect the AC power cable before cleaning the monitor and sensor.
- Shock Hazard! Never immerse the monitor. The monitor has an internal power source that is active when the unit is unplugged.

Do not use abrasive cleaners on the monitor or on any sensors or probes. Abrasive cleaners can damage the monitor, sensors, and probes.

The exterior surface of the monitor, except for the display screen, may be wiped clean with alcohol and dried with a soft, dry cloth. It is best to use a cotton cloth to clean the monitor. Paper towels or tissues can scratch the surface of the display.

Do not use full strength alcohol on the display screen. Repeated use of strong cleaners can damage the screen. Clean the display window by wiping it with a clean, soft, lint-free cloth sprayed with common glass cleaner. Do not spray glass cleaner directly on the display.

Pulse Oximeter Sensors

⚠CAUTION⚠

- Do not immerse any Criticare pulse oximeter sensor connector in any liquid. Doing so may damage the connector.

You can wipe the SpO_2 sensor clean with alcohol. To disinfect the SpO_2 sensor place the finger clip and cable in a 2% glutaraldehyde solution. Place only the sensor finger clip and cable in the solution; do not place the sensor electrical connector in the solution.

Blood Pressure Cuffs

To clean the reusable blood pressure cuff wipe it with a damp cloth or sponge. If necessary, the cuff may be disinfected by wiping with 70% alcohol, mild bleach solution, or other disinfectant. Disposable blood pressure cuffs are for single patient use and are not intended to be disinfected.

You can sterilize the cloth cuff and neoprene bag with commercially available disinfectants such as ethylene oxide (ETO). Rinse thoroughly to remove any residual disinfectants. Do not allow liquids to enter the neoprene bag. The cloth cuff may also be sterilized in an autoclave.

If the cuffs become grossly soiled with blood or other body fluids, launder the cloth cuffs by hand or machine. You can launder or sterilize the dacron cloth cuff. First, remove the neoprene inflation bag. Then, feed the inflation tube back through the hole and then pull out the cloth flap.

Figure 4-1: Remove Inflation Bag from Cuff

Roll up the inflation bag and slide it out the open slot in the cloth cuff. Be sure to observe the following laundering precautions (disposable cuffs and neoprene inserts should not be laundered.)

- Remove the inflatable bag from the cuff before laundering or sterilizing the cuff.
- Strong bleach solutions will damage the cuff.
- Temperatures over 275° F (135° C) will damage the cuff.
- Close the Velcro® fastener before laundering the cuff.
- Soaking the cuff in dark-colored solutions may stain or discolor the cuff.

Hand laundering (as opposed to machine laundering) prolongs the life of the cuff. Wash the cuff in warm, soapy water. Rinse the cuff thoroughly. After you clean the cuff allow the cuff to air dry and then insert the inflation bag in the cuff.

ECG Cable

You can clean the ECG cable and leads with alcohol. Do not immerse the connections.

Temperature Cable

Clean the cable according to hospital protocol for cleaning of reusable equipment cables. Typically this protocol consists of the following:

1. Disconnect the cable from the monitor and temperature sensor.
2. Wipe the cable with a nonabrasive cloth moistened with a mild detergent and warm water or a disinfectant. Dry thoroughly.
3. Do not use alcohol or solvents to clean the cable.
4. Do not allow the cable connectors and contact points to come in contact with liquids.
5. Do not fully immerse the cable in liquids.
6. Do not autoclave or ETO sterilize the cable.

Accidental Wetting

⚠WARNING⚠

- Shock Hazard! The monitor is an AC powered device and an immersed monitor presents a danger to anyone who handles the device.

The action to be taken following accidental wetting of the equipment is as follows:

1. Turn the power off! Disconnect the AC power cord from the monitor.
2. If monitoring a patient, transfer the patient to another monitor as quickly as possible.
3. Use a clean, dry towel or cloth to remove the liquid from the monitor housing.
4. as soon as possible, a service technician should inspected the monitor.
5. If the internal mechanism is saturated, allow the liquid to drain out for 24 hours before shipping.
6. If liquid has entered the monitor, it needs to be dried and cleaned internally. Full testing is required before you can use the monitor. Contact the CSI Service Department as soon as possible.

Time is critical! The longer any liquid remains in the monitor, the more damage it can do. It is important to service the monitor immediately after any liquid is spilled into it.

Section 5 — Preventative Maintenance

Incoming Inspection

You must inspect monitors coming back from service for shipping damage before you place them into operation just like newly purchased monitors. The monitor should be free from dents, cracks, or other physical damage. The quality inspection seal of the monitor should be unbroken, indicating that the monitor has been tested according to manufacturer's specifications.

If further incoming inspection or testing is required, the manufacturer recommends that you use the "Alarms Verification" on page 5-13 as an incoming inspection test. You can perform additional electrical safety testing in this section as part of an incoming inspection in accordance with the policies of the health care provider.

Maintenance Schedule

Every Patient	• Clean and disinfect the NIBP cuff as needed. • Inspect, clean, and disinfect the oximeter sensor. • Inspect the accessories and charger for damage.
Every Day	• Charge the monitor's battery as necessary.
Every 3 Months	• Clean the exterior of the unit (or clean as needed).
Every Year	• Perform the annual safety tests described in the service manual.

Monitor Safety Testing

You can perform the following tests as part of a periodic safety check. The following safety tests are designed so that the monitor's warranty seal does not have to be broken. If the monitor fails any portion of these tests, contact the CSI service department.

The contents of this section include the following verifications and safety tests:

- Electrical Safety Testing
- Withstanding Voltage (Hi-Pot)
- Electrical Leakage
- Functional Testing, including:
- Interface Inspection
- Manual Controls Check
- Alarm Verification
- Vital Sign Modules Verification:
  - ECG
  - SpO_2
  - NIBP
  - Temperature
  - Internal Printer
- Communications

Criticare recommends that you run a serviced monitor for 24 hours (less 4 hours for shipping) before you perform the tests listed above and place the monitor back into service. Repaired modules could require more extensive testing.

Always follow ESD precautions when performing a procedure discussed in this section.

⚠WARNING⚠

- Because test procedures require working with exposed electrical circuits, only experienced electrical or biomedical technicians should perform the procedures.
- After a monitor is altered through repair or hardware adjustment, you must fully test it before use.

Equipment and Tools

The following procedures assume that the technician has an ESD safe workbench, a set of electronic hand tools, and a digital multimeter with a 10-amp setting. At the beginning of each test, special equipment can be listed. A variety of customized cables, clips, and test fixtures are also needed to complete the tests. For more information, contact the CSI Service Department.

Accessory Testing

Check patient cables (e.g., temperature cables, printer cables) monthly for damage, loose wires/connections, loose connectors, cracked housing, etc.

Check the electrical safety of the charger as part of the monitor safety testing.

Check the cuffs for leakage as part of the NIBP verification.

Battery Safety

The batteries require no maintenance. For more information, refer to the *Scholar® III Model 507ELC2 Series Operator's Manual*.

⚠CAUTION⚠

- Do not short circuit the battery terminals! The resulting high-current discharge can cause burns.
- Charge the battery completely after extended battery use to ensure a fully-charged battery is available for the next use.
- Explosion hazard! Keep lighted cigarettes, sparks, and flames away from the battery.
- The battery contains sulfuric acid electrolyte that can cause severe burns and eye damage, as well as illness from sulfur oxide fumes.
- Do not crack, cut, burn, or dissolve (with solvents) the battery case. Damaging the battery case can cause the release of sulfuric acid. If sulfuric acid is released from the battery, wear eye protection and rubber gloves to handle the battery, and use a solution of baking soda in water to neutralize the sulfuric acid.
- The used battery is a potential environmental hazard and must be disposed of properly. Dispose the old battery in accordance with local and federal laws. Do not incinerate.

Battery Replacement

The battery access door is on the bottom of the monitor.

Removing the Battery

1. Turn the monitor off and disconnect the charger cord from the back of the monitor.
2. Turn the unit upside down and place it on the work surface.
3. Pull the rubber inserts straight up to remove them from the feet
4. Remove the three Phillips screws.
5. Tilt the battery cover up from the front edge. You may need to gently pry the cover open with a small flathead screwdriver.
6. Lift the battery cover straight up to remove it.

⚠CAUTION⚠

- In the next step, be sure to pull only on the battery end of the cable, NOT the end of the cable that is connected to the monitor.

7. Gently pull on the wires attached to the battery terminals to lift the battery out of the battery compartment.

8. Release the latch on the battery cable connector.
9. Disconnect the battery cable at the connector.

⚠WARNING⚠

- The used battery is a potential environmental hazard and you must dispose of it according to local requirements or return it to CSI.

Installing the New Battery

1. Connect the cable from the new battery to the battery cable connector on the monitor.
2. Position the battery cable so that it is not pinched or excessively pulled. Slide the new battery into position in the battery compartment.
3. Reattach the battery compartment door with the three Phillips screws. The short screw goes in the middle.
4. Reattach the rubber inserts to the feet.

   NOTE: When you replace the feet, be sure to align the small projection on each foot with the matching depression in the case.
5. Reconnect the power cord to the monitor. Allow the battery to charge for 10 hours before you operate the monitor on battery power.

Battery Maintenance

The battery requires no maintenance.

Long-term Storage

No special preparation is necessary for long-term storage of the monitor.

Disposal

At the end of its useful life, the monitor and its accessories may be disposed of according to your institution's policies and procedures for disposal of patient-contact medical waste.

Alternately, the monitor and its accessories may be returned to Criticare Systems, Inc., for safe disposal. The shipping address is:

Criticare Systems, Inc.
20925 Crossroads Circle, Suite 100
Waukesha, WI 53186

Electrical Safety Testing

Scholar III Withstanding Voltage Hi-Pot Test

Perform this test whenever opening the monitor housing and before using the monitor on patients.

⚠WARNING⚠

- Shock Hazard! Because dangerous and lethal voltages are present during the withstanding voltage, leakage, and ground continuity test, all leakage and voltage testing must be done with the monitor housing in place. For complete information about the proper operating and safety procedures, refer to the **Operator's Manual**.

Equipment Needed

The following are needed to complete this procedure:

- Associated Research 3565D Dielectric Withstand Tester (or equivalent Hi-Pot tester)

Hi-Pot Performance

NOTE: Do not power up the 507ELC2 monitor during Hi-Pot steps.

MAINS INPUT TO POWER GROUND TEST

1. Connect the red lead of the tester to the shorted (black, white) of the AC input test connector. Plug the test connector into the Cat. 924 AC input. Connect the black lead of the tester to the power ground (green) wire of the AC input test connector.

   NOTE: Do not connect to the capacitor. Connect directly to ground.

2. Turn on the tester power. Press the "TEST" switch. 1500 VAC is applied to the 507EL monitor for 1 second. No voltage breakdown (HI-POT FAIL) indication should occur.

3. Hi-Pot hot and neutral to ground with 1500VAC @ 2mA for 1 second.
   a. Connect the CSI CORD HI-POT SETUP CABLE into the Transformer (CAT 924), with the RED lead of the Hi-Pot connected to the shorted black and white (hot and neutral) of the CSI CORD HI-POT SETUP CABLE.

   b. Place the BLACK lead of the hipot tester to the green wire (ground) of the CSI CORD HI-POT SETUP CABLE.

   c. Conduct the test and verify that the Hi-Pot tester indicates pass.

4. Hi-Pot BNC to ground with 1500VAC @ 2mA for 1 second.
   a. With the same setup as above, move the RED lead of the Hi-Pot tester to the BNC connector.

   b. Conduct the test and verify that the Hi-Pot tester indicates pass.

MAINS INPUT TO PATIENT / EXTERNAL EQUIPMENT CONNECTION TEST

NOTE: For the following series of tests, use the CHARGER /507E/ EL HI-POT SETUP device.

NOTE: For the following series of tests, the 2200 pf Y-capacitor is connected between the power ground of the Cat. 924 and the specific input being tested during any one test (see "Connecting the Y-Capacitor"). The tester black lead is also connected to the input under test. The function of the 2200 pf capacitor is to form part of an AC voltage divider in conjunction with a 1000 pf capacitor which is internal to the Cat. 924 in order to protect the output circuitry and the 1000 pf capacitor in the Cat. 924 from over load.

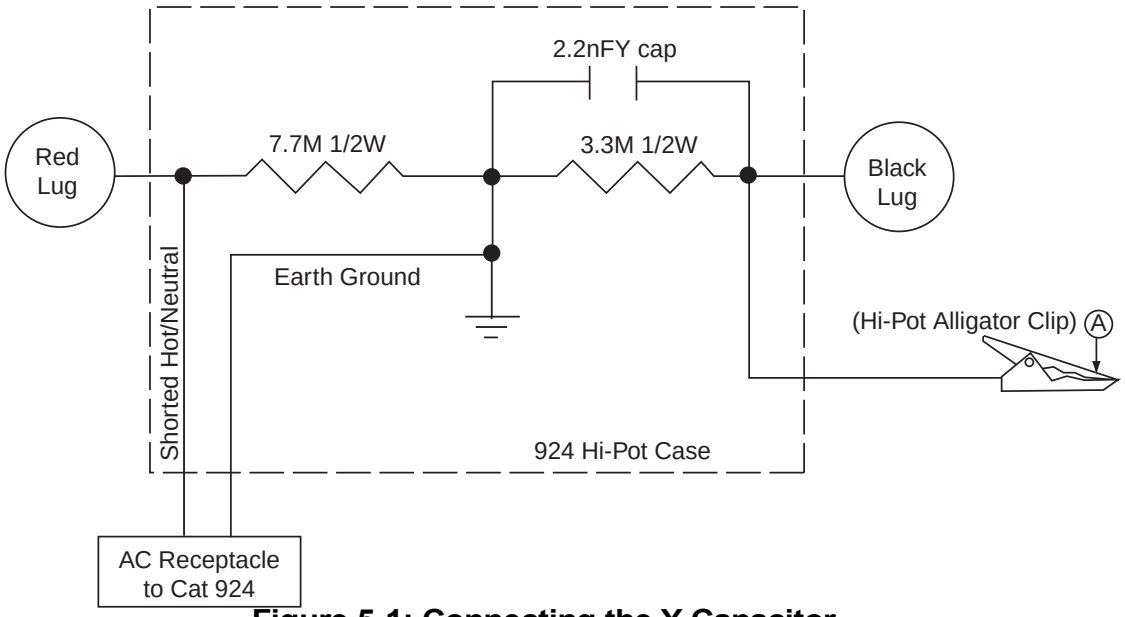


Figure 5-1: Connecting the Y-Capacitor

1. Connect the test connector for ECG to the 507EL monitor

2. Hi-Pot CHARGER /507E/EL HIPOT SETUP to ECG with 5700VDC @ 2mA for 1 second. (Switch to DC)
   a. Connect the F-PIN ECG HI-POT CABLE to the 507ELC2 monitor.
   b. Now connect CHARGER/507E/EL HI-POT SETUP to the 924 with the Hi-Pot leads connected to the terminals on the setup marked with red and black markers.
   c. Connect the black wire from CHARGER/507E/EL HI-POT SETUP to the ECG connector of the 507EL monitor.
   d. Conduct the test and verify that the Hi-Pot tester indicates pass.
3. Hi-Pot CHARGER /507E/EL HI-POT SETUP to BNC with 5700VDC @ 2mA for 1 second.
   a. With the same setup, connect the black wire from CHARGER /507E/EL HI-POT SETUP to the BNC connector found on the back of the unit.
   b. Conduct the test and verify that the Hi-Pot tester indicates pass.
4. Hi-Pot ECG to DB-9 with 4000VAC @ 2mA for 1 second. (Switch to AC)
   a. Connect the Red lead of the Hi-Pot tester to the F-PIN ECG CABLE.
   b. Connect the black lead of the Hi-Pot tester to the DB-9 HI-POT ISO/GND CABLE connected to the interface connector located on the back of the 507EL monitor.
   c. Conduct the test and verify that the Hi-Pot tester indicates pass.

Leakage

NOTE: The cover should stay on for the leakage tests. Perform a self test on the Dynatech 232D.

1. Turn on the unit. Set the MODE switch to SELF test. The display should read 1000 ±20 and the current source active lamp should be on.

⚠CAUTION⚠

- If these conditions are not met, do not continue with the leakage test.

2. Set the MODE switch on the Dynatech to L1-L2. The display should read 110 to 130 VAC. Set the MODE switch to L1-GND. The display should read no more than 5% of the previous line voltage measurement. Set the MODE switch to L2-GND. This reading should be the same as the first reading, ±5 VAC.

3. Set the “MODE” switch to “CASE LEAKAGE/GROUND CONDUCTOR.” Connect the AC cord from the Dynatech to the AC input of the Scholar III patient monitor. Turn the Scholar III patient monitor on for the remaining leakage tests. With the “POLARITY” switch in the “NORMAL” position, monitor the readout for less than 50 μA.
4. Change the “POLARITY” switch to the “REVERSE” position and accept a reading of less than 50 μA.
5. With the “POLARITY” switch in the “NORMAL” position. Press the “OPEN NEUTRAL” switch and accept a reading of less than 90 μA.
6. Change the “POLARITY” switch to the “REVERSE” position and press the “OPEN NEUTRAL” switch and accept less than 90 μA.
7. Press the “OPEN GROUND” button. Accept a reading of less than 50 μA.
8. Set the “POLARITY” switch to the “REVERSE” position. Accept a reading of less than 50 μA.
9. Connect the Dynatech to the Scholar III patient monitor using the 3 lead ECG cable. Set the “MODE” switch to “ECG to GND.” For the rest of the leakage tests, ensure that the leads are dressed away from any ground planes, the AC power cord, and the chassis. Set the “MODE” switch to “ECG TO GND.” Set the “LEADS” switch to “ALL.” Set the “POLARITY” switch to “NORMAL.” Accept a reading of less than 50 μA.
10. Press the “OPEN NEUTRAL” button. Accept a reading of less than 50μA. The green AC light turns off.
11. Press the “OPEN GROUND” button. Accept a reading of less than 50 μA.
12. Set the “POLARITY” switch to the “REVERSE” position. Press the “OPEN NEUTRAL” button. Accept a reading of less than 50 μA.
13. Press the “OPEN GROUND” button. Accept a reading of less than 50 μA.
14. Set the “LEADS” switch to the “RA-LA INTERLEAD” position. Set the “POLARITY” switch to the “NORMAL” position. Accept a reading of less than 20 μA.
15. Set the “LEADS” switch to the “RA-RL INTERLEAD” position. Accept a reading of less than 20 μA.
16. Set the “LEADS” switch to the “LA-RL INTERLEAD” position. Accept a reading of less than 20 μA.
17. Set the “LEADS” switch to the “ISO” position. Press the “ISOLATION TEST” button. Accept a reading of less than 20 μA.

18. Connect the bare wire end of the temperature leakage cable to any of the ECG test terminals on the Dynatech. Plug the other end of the leakage cable into the TEMP input of the Scholar III patient monitor. Accept a reading of less than 20 μA. (See “Figure 5-2: Temperature Receptacle Test Plug” to fabricate).

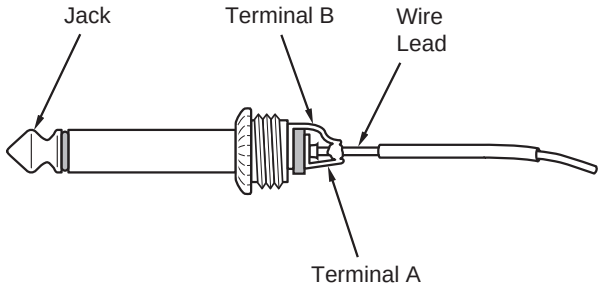


Figure 5-2: Temperature Receptacle Test Plug

Functional Testing

Interface Inspection

This procedure is primarily for monitors with TFT active displays.

1. Verify that a readable screen displays. For a guide to proper screen layout, refer to Section 3, “Setup Procedures,” in the *Scholar® III Model 507ELC2 Series Operator’s Manual* for sample screens.
2. Verify that the screen display is clear and bright when directly facing the monitor.
3. Verify the image quality. There should be no intermittence or jittering of pixels. The maximum amount of pixels missing from any display are as follows:

- Maximum number of bad dots allowed per screen is 7.
- Maximum number of bad dots within any 20mm circle is 2.

Manual Controls Check

1. Press the FREEZE key to freeze the bottom *two* ECG waveforms. The top ECG waveform remains in real time. Verify that you get an audible response from the speaker. Press the DISPLAY key to unlock the waveforms.
2. Press the START/STAT/STOP key. Verify that you get an audible response from the speaker. The pump should operate.
3. Press the SET ALARM key. Verify that you get an audible response from the speaker. A *Set Alarm* window appears on the display. Press the SET ALARM key and verify that the curser moves from item to item on the menu. Press the DISPLAY key to close the *Set Alarm* window.
4. Press the SETUP key. Verify that you get an audible response from the speaker. A *Setup* window appears on the display. Press the SETUP key and verify that the curser moves from item to item on the menu. Press the DISPLAY key to close the *Setup* window.
5. Press and hold the SETUP key. Verify that you get an audible response from the speaker, followed by a double beep and the second *Setup* window displays. Press the SETUP key and verify that the curser moves from item to item on the menu. Set the *DATE* and *TIME* for the real time clock. Press the DISPLAY key to close the *Setup* window.
6. Press the DISPLAY key. Verify that you get an audible response from the speaker. An *ECG 50MM* window appears on the display. Press the DISPLAY key again. Verify an audible response from the speaker. A *Numerical Display* window appears on the display. Press the DISPLAY key again. Verify an audible response from the speaker. A *Three-lead* window appears on the display. The three leads should be ECG/ Cascade and SpO_2.

7. Press the TREND key. Verify an audible response from the speaker. A *Trend* window appears on the display. Press the DISPLAY key to close the *Trend* window.
8. Press the PRINT key. Verify an audible response from the speaker. The printer prints a test strip.

SPEAKER

Verify speaker operation.

1. Plug an SpO_2 sensor into the SpO_2 port on the 507ELC2.
2. Wait for the SpO_2 to detect a pulse.
3. Press the SETUP key to open the *Setup* window.
4. Press the SETUP key to highlight *Pulse Vol:*. Use the UP ARROW and the DOWN ARROW keys and verify that the speaker increases and decreases in sound at a constant rate.
5. Press the DOWN ARROW key to select *OFF*. Verify that the tone stops.

LED TEST

1. Press the ON/OFF key and the DOWN ARROW key of the monitor at the same time. The Service tools screen appears.
2. Press the DISPLAY key.
3. Observe the LED's. They display an "8" on all 7-segment LED's, then "0" and count to "9." Observe that all the proper numbers display.

TIME AND DATE

With the unit powered up:

1. Press the SETUP key.
2. Go to the second *Setup* screen and cursor over to the time and date using the SETUP key.
3. Set the *TIME:* and *DATE:* using the UP and DOWN ARROW keys.

Alarms Verification

To verify alarm circuitry, perform the following procedure.

1. Press the SET ALARM key to enter the *Set Alarm* menu. Set the *ALARM VOLUME* to *10* in the *Set Alarm* menu.
2. Enter the *Setup* menu and turn off temperature monitoring (*TEMP*). The display for *TEMP:* should read *OFF*.
3. With no cuff attached press the START/STAT/STOP key. The monitor attempts to inflate and responds with a *BP: CHECK CUFF* message.
4. Listen for the low level alarm tone, a burst of two pulses at the same pitch. The bursts should repeat every 10 seconds.
5. Set the *ALARM LEVEL* to *1* and cause another *CHECK CUFF* alarm. The volume should be decreased but still audible.
6. Set the *ALARM VOLUME* to *OFF* and cause another *CHECK CUFF* alarm. No alarm tone should be audible. Confirm that the ALARM SILENCE LED is flashing red.
7. Return the *ALARM VOLUME* setting to *5*.
8. Press the SET ALARM key to enter the *Set Alarm* menu. Check the NIBP alarm settings. Set the high diastolic setting (*DIA:*) to 60.
9. Attach an NIBP simulator to the monitor.
10. Set the simulator's diastolic to 100 (above the setting of the monitor's alarm).
11. Listen for the medium level alarm tone. It should appear at a higher pitch than the low level alarm tone. It is a burst of three pulses all at the same pitch. The bursts should repeat every 25 seconds.
12. In the *SET ALARM* window adjust the SpO_2 low alarm level above the saturation reading to cause an alarm condition.
13. Verify that the message *LOW SPO2* appears at the bottom of the display in red letters.
14. Verify that you get an audible response. The alarm should be a high priority alarm tone consisting of 3 beeps followed shortly by two beeps.
15. Return the monitor to its standard default settings.

ALARM LED'S

Power the unit off, then on. Upon power-up, the speaker should provide a power-up tone. When pressing each front panel key, there should be a tone from the speaker (except for *ALARM SILENCE*). Along with that selected function should be a change in the operation of the Unit. When pressing ALARM SILENCE, either the 2 minute LED (solid red) or the OFF LED (flashing red) illuminates depending on the length of time the key is pressed.

Vital Sign Modules Verification

ECG Verification

1. Verification that the ECG baseline is centered.
   a. To verify the ECG baseline is centered, press the UP ARROW key to set up the unit to the *X4* scale.
   b. Press the SETUP key to set up the unit for the *Lead II* configuration.
   c. Press the UP ARROW key to set up the unit for 1mv ECG.
   d. Press the SETUP key and set up the unit for input *FILTER: OFF*.
   e. Verify that the ECG baseline is centered with an ECG signal present (±4 pixels). See “Figure 5-3: ECG Baseline”.

Figure 5-3: ECG Baseline

2. Check the DB-9 connector for telemetry compatibility. Verify +5V is present at pin 4 of the DB-9 connector.
3. Connect an ECG patient cable to the ECG jack on the Scholar III patient monitor. Connect an ECG simulator to the snap ends of the patient cable as follows:

RED	LL
WHITE	RA
BLACK	LA

   Set the ECG output to 60 BPM, then set the RESPIRATION RATE to 60.
   - The HEART RATE (BPM) 7-segment displays indicate the setting of the pulse setting of the simulator. The HEART RATE should be ±2 counts of what the ECG simulator is set for.
   - The SpO2% 7-segment displays flashes a bar across each of the numbers.
   - The RESPIRATION RATE (*RESP:*) displays on the upper right corner of the LCD with a numeric value.
4. The Scholar III patient monitor can use (3) different lead configurations for the ECG. Press the SETUP key until the *LEAD* selection is highlighted. Press the UP ARROW key to cycle through *LEAD: I*, *II*, or *III*. The lead configuration displays on the top of the display.

5. With the Scholar III patient monitor set up for *LEAD I*, verify the ECG waveform. (See “Figure 5-4: Lead I ECG Waveform”).

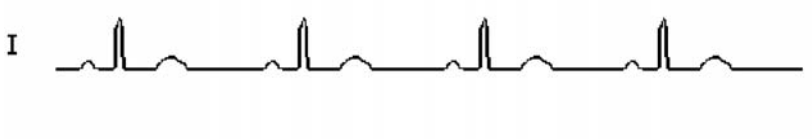


Figure 5-4: Lead I ECG Waveform

6. Disconnect the white lead from the simulator. The waveform should disappear and the base line should return to the middle of the display. The HEART RATE should decay and a *RA LEAD OFF* message appears.
7. Reconnect the white lead and the waveform should return to normal, with a normal heart rate.
8. Disconnect the black lead from the simulator. The waveform should disappear and the base line should return to the middle of the display. The HEART RATE should decay and the *LA LEAD OFF* message appears.
9. Reconnect the black lead and the waveform should return to normal.
10. Disconnect the red lead from the simulator. The waveform should disappear and the base line should return to the middle of the display. The HEART RATE should decay and a *LEADS OFF* message appears.
11. Reconnect the red lead and the waveform should return to normal.
12. With the Scholar III patient monitor set up for *LEAD II*, verify the ECG waveform (See “Figure 5-5: Lead II ECG Waveform”).

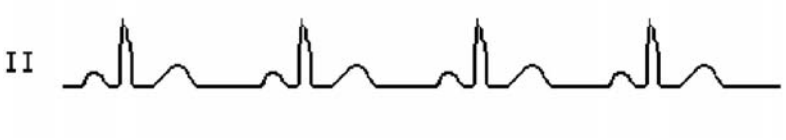


Figure 5-5: Lead II ECG Waveform

13. With the Scholar III patient monitor set up for *LEAD III*, verify the ECG waveform. (See “Figure 5-6: Lead III ECG Waveform”).

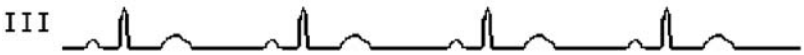


Figure 5-6: Lead III ECG Waveform

14. With the Scholar III patient monitor set up in *LEAD II* with a stable waveform and heart rate, turn the simulator off. In less than 10 seconds the *ECG LOST* alarm should sound.

15. Press the TREND key and review the *Trend* screen. Verify that the *Trend* screen is holding data. Power down the unit. Power up the unit and press the TREND key and review the trend data. The unit should retain trend data. Observe the data that is stored from the previous tests.

Oximeter (SpO_2) Verification

1. With the unit powered up and with no sensor connected to the receptacle, the message *NO SENSOR* displays at the bottom of the Scholar III patient monitor display.
2. Connect the Cat. 511 Finger Sensor to the sensor receptacle and position it on a finger. Within 15 seconds, valid and stable O_2 saturation and pulse rate readings display on the Scholar III LED display and within the SpO_2 waveform box and Rate parameter box on the LCD. The waveform box also displays a characteristic plethysmograph waveform without noise, oscillation, or other distortion or artifacts. Saturation and pulse values as well as wave shape may vary somewhat from one test subject to another. There shall be no error messages except possible alarm limit violations present on the display (*SpO2 TOO LOW*/*HIGH* or *HEART RATE TOO LOW*/*HIGH* are alarm violations).
3. Remove the sensor from the finger and install an optical load (such as a foam peanut) into the sensor. After a time delay specified by the *SEARCH DELAY* setting in the SpO_2 parameter box menu (default = 20 seconds), the *SpO2 LOST* message appears.
4. Remove the optical load from the finger clip and slowly open the sensor finger clip while holding the sensor near a fluorescent light source. It may be necessary to move the sensor back and forth slightly in order to induce signal saturation. The *SpO2 HIGH AMBIENT* message appears on the display. Remove the sensor from the light source and reposition it on the finger. The message disappears from the display.

NIBP Verification

For both the 120/80 operation setting and the 80/50 operation setting, the monitor is connected to a Dynatech Nevada NIBP Analyzer.

1. Use the T-connection with the dummy cuffs for these tests. Connect them to the 0-300 mmHg port of the NIBP analyzer.
2. Connect the monitor to an AC (mains) power source and turn on the monitor.
3. Press the monitor's CYCLE TIME key. The monitor's cycle time window appears.
4. Select the *NIBP Cycle Time* to two minutes.

120/80 OPERATION SETTING

Use an adult dummy cuff for this test. Set the initial Dynatech Nevada NIBP simulator settings of **Adult** at **120/80 (90)** and **Heart Rate** at **80 bpm**.

1. Press the SETUP key. In the monitor's *SETUP 1* window set the *Patient Size* to *Adult* mode.
2. For the Pressure Cure Adjustments, set *SHIFT* to *0* (zero) and *GAIN* to *100%*.
3. Press the NIBP START/STAT/STOP key.
4. Allow the monitor to take at least three readings. Systolic and diastolic readings should appear. The average of the three readings should be within 4% or 4mmhg of all the readings taken.
5. Recalibrate the monitor if necessary.

80/50 OPERATION SETTING

Use a neonate dummy cuff for this test. Set the initial Dynatech Nevada NIBP simulator settings of **Neo** at **80/50 (62)**.

1. Set the monitor to the *Neonate* mode.
2. To verify *STAT* mode operation, press and hold the NIBP START/STAT/STOP key.
3. Allow the monitor to take at least three readings. Systolic and diastolic readings should appear on the display.
4. Take the average of the three readings. Each reading should be within 4% or 4mmhg of all the readings taken.

Temperature Verification

1. Press the SETUP key to enter the *SETUP MENU 1*.
2. Press the SETUP key until *TEMPERATURE* highlights.
3. Using the UP or DOWN Arrow turn the temperature function on.
4. Press the DISPLAY key to return to the waveform display.
5. Verify the *TEMP: NO PROBE* message appears when no probe is attached.
6. Connect a FOGG TP-400 temperature simulator to the TEMP input.
7. Set the TP-400 to the temperature settings in the table below. Verify that the temperature display is within the table limits.

Table 1:

TP-400 Setting	Display Limits
68 °F	67.8- 68.2 °F
77 °F	76.8 - 77.2 ° F
86 °F	85.8 - 86.2 °F
95 °F	94.8 - 95.2 °F
96.8 °F	96.6-- 97.0 °F
98.6 °F	98.4 - 98.8 °F
100.4 °F	100.2 -100.6 ° F
102.2 °F	102.0 - 102.4 °F
104 °F	103.8 - 104.2 ° F
113 ° F	112.8 - 113.2 °F

8. Verify *LOW TEMP* message appears.
9. Verify *HIGH TEMP* message appears.

Printer Testing

NOTE: These steps apply only to the 507ELC2 monitor.

1. Press the PRINT key on the keypad. Ensure that a strip prints with the monitor model number, software revision, date, and time.
2. Press the PAPER FEED key and ensure the paper feeds through the roller.
3. Press and hold the SETUP key to configure *SETUP MENU 2*.
4. Press the SETUP key until *WAVEFORM:* is highlighted.
5. Press the UP arrow key to select *WAVEFORM: 8 SEC*. Press the DISPLAY key to return.
6. Connect an ECG simulator set for 60 bpm.
7. Print out an ECG waveform.

Scholar III Final Test
Check Sheet

Unit serial number_____

Software Rev._____

Tested by_____

Date_____

Test		Pass	Fail
Electrical Safety Testing			
Withstanding Voltage Hi-Pot Test			
Mains Input to Power Ground Test			
Hi-Pot 1500 V to ground.		PASS_____	FAIL_____
Hi-Pot HOT and NEUTRAL to ground with 1500VAC @ 2mA (1 second)		PASS_____	FAIL_____
Hi-Pot BNC to ground with 1500VAC @ 2mA (1 second)		PASS_____	FAIL_____
Hi-Pot CHARGER/507E/EL HI-POT SETUP to ECG with 5700VDC @ 2mA (1 second; switch to DC)		PASS_____	FAIL_____
Hi-Pot CHARGER/507E/EL HI-POT SETUP to ECG with 5700VDC @ 2mA (1 second)		PASS_____	FAIL_____
Hi-Pot ECG to DB-9 with 4000VAC @ 2mA (1 second; switch to AC)		PASS_____	FAIL_____
Leakage			
Leakage Open ground		PASS_____	FAIL_____
Mode Switch Reading		PASS_____	FAIL_____
Reverse position polarity Switch.		PASS_____	FAIL_____
Open Neutral Normal (<90µA)		PASS_____	FAIL_____
Open Neutral Reverse (<90µA)		PASS_____	FAIL_____
Leakage Open Ground (<50µA)		PASS_____	FAIL_____
Polarity Reverse (<50µA)		PASS_____	FAIL_____
All Leads Normal (<50µA)		PASS_____	FAIL_____
Open Neutral (<50µA)		PASS_____	FAIL_____
Open Ground (< 50µA)		PASS_____	FAIL_____
Open Neutral (<50µA)		PASS_____	FAIL_____
Open Neutral (<50µA)		PASS_____	FAIL_____
RA-LA		PASS_____	FAIL_____
RA- RL		PASS_____	FAIL_____
LA-RL		PASS_____	FAIL_____
Isolation Test		PASS_____	FAIL_____
Leakage Temperature (<20uA)		PASS_____	FAIL_____

Functional Testing

Interface Inspection	PASS_____	FAIL_____
Manual Controls Check	PASS_____	FAIL_____
Shut Off: Verify Unit Shut down. (10.9 ±0.2VDC)	PASS_____	FAIL_____
Speaker: Perform the Speaker Test.	PASS_____	FAIL_____
LED Functionality: Perform LED DISPLAY Test.	PASS_____	FAIL_____
Time and Date: Set date and time in the Setup screen.	PASS_____	FAIL_____

Alarms Testing

Alarm Volume	PASS_____	FAIL_____
Alarm LEDs: Verify Operation of all membrane switch key.	PASS_____	FAIL_____

ECG Functionality

Verify ECG Baseline	PASS_____	FAIL_____
Perform Analog Output Calibration	PASS_____	FAIL_____
Verify 5V at DB-9 pin 4	PASS_____	FAIL_____
Verify HR and RR Readings	PASS_____	FAIL_____
Verify Lead I ECG Waveform	PASS_____	FAIL_____
Verify Lead Off Message(White Lead)	PASS_____	FAIL_____
Reconnect (White Lead) observe ECG waveform	PASS_____	FAIL_____
Verify Lead Off Message (Black Lead)	PASS_____	FAIL_____
Reconnect (Black Lead) observe ECG waveform	PASS_____	FAIL_____
Verify Lead II ECG waveform	PASS_____	FAIL_____
Verify Lead III ECG waveform	PASS_____	FAIL_____
Verify ECG Lost	PASS_____	FAIL_____

Oximeter Functionality

Verify NO Sensor	PASS_____	FAIL_____
Verify SpO_2 Readings	PASS_____	FAIL_____
Verify SpO_2 Lost	PASS_____	FAIL_____
Verify High Ambient Condition	PASS_____	FAIL_____
Perform Computer SPO_2 Simulator Test	PASS_____	FAIL_____

NIBP Functionality

Verify 1.75 Hour Trend	PASS_____	FAIL_____
Perform the Adult & Neonate Simulator Test.	PASS_____	FAIL_____

Temperature Functionality

Verify Temperature Limits.	PASS_____	FAIL_____

Printer Testing (507ELC2 only)

PRINT key	PASS_____	FAIL_____
PAPER FEED key	PASS_____	FAIL_____
ECG Waveform printout	PASS_____	FAIL_____

DATE ON_____ TIME _____

CERTIFICATION THAT THE UNIT IS CALIBRATED AND FUNCTIONING PROPERLY.

NAME_____DATE _____

This checklist may be copied as needed to record field testing

Section 6 —Service Testing and Calibration

Field Service Testing Safety

⚠WARNING⚠

- Service testing procedures require working with exposed electrical circuits and should only be attempted by experienced electrical or biomedical technicians.
- When a monitor is altered through repair or hardware adjustment, it should be fully tested before use.

⚠CAUTION⚠

- Always follow ESD precautions when performing any procedure discussed in this section.
- The manufacturer recommends that a serviced monitor be allowed to run for 24 hours before the monitor is placed back into operation.
- Modules and PCBs that have been repaired may require more extensive testing than what is described in this manual.

The pre-assembly testing of printed circuit boards (PCBs) is not covered in this manual. Disassembly of surface mounted components on PCBs is not recommended. Tests provided here are only for the identification of damaged or degraded PCBs.

Field Service Test Matrix

Any time you open a monitor's case you must perform electrical safety tests before you return the monitor to operation. If you service the monitor, you should also perform the functional tests.

You should perform additional tests that are specific to modules and assemblies when you service, adjust, calibrate, or disassemble assemblies. See the following table.

Field Service Testing ● Required Test ✔ Recommended Test	Withstanding Voltage (Hipot)	Electrical Leakage	Functional Testing	ECG Verification	SPO_2 Verification	NIBP Verification	Temperature Verification	Printer Testing (507ELC2 only)	SpO2 Performance Test	NIBP Module Calibration	Temperature Check	Main Board Testing
No Fault (case opened)	✔	●	✔									
NIBP Pump and Board	✔	●	✔			●				●		
SPO2 Board	✔	●	✔		●				●			
ECG-Resp.-Temp Board	✔	●	✔	●	✔		●		●		●	
Main Board	✔	●	●	●	●	●	✔	●	●	●	●	●
Key Pad	✔	●	●	✔	✔	✔	✔	✔				
Printer and/or Board (507ELC2 only)	✔	●	✔					✔				
Instrument Dropped	✔	✔	✔	✔	✔	✔	✔	✔				
Software Download			●	✔	✔	✔	✔	✔				
Annual Safety Test	✔	●	✔	✔	✔	✔	✔	✔				

Equipment Required

The following tools are needed:

- Digital voltmeter
- Variable DC power supply 10-15 VDC/ 5A
- Manometer
- Power test cable (See “Power Test Cable” on page 6-4 to fabricate)
- Dynatech model 232 leakage tester
- Cat. 924 power supply
- Battery load simulator cable
- Dynatech cufflink w/neonatal and adult cuff
- 700 cc factory test block.
- "TEE" connector K. Dynatech 217A or Medsim 300 ECG simulator
- Fogg TP 400 temperature simulator
- Cat. 913 SpO_2 simulator
- Frequency counter
- Oscilloscope
- 3 Lead ECG cable, LL2314
- Pigtail test cable Ay
- Associated Research 3565D Dielectric Withstand Tester (or equivalent Hi-Pot tester)
- Scholar III 507ELC2 monitor, including Cat. 924 power supply module (connected)
- AC Input Test Connector (see “AC Input Test Connector” on page 6-4 to fabricate) with 2200 pf Y-capacitor (CSI pn 20004B019) attached to power ground (green) wire
- Hi-Pot Test connector for ECG, SpO_2, Temp, and DB-9
- NIBP Setup Computer, CSI tool #1331 (For CSI in-house use only)

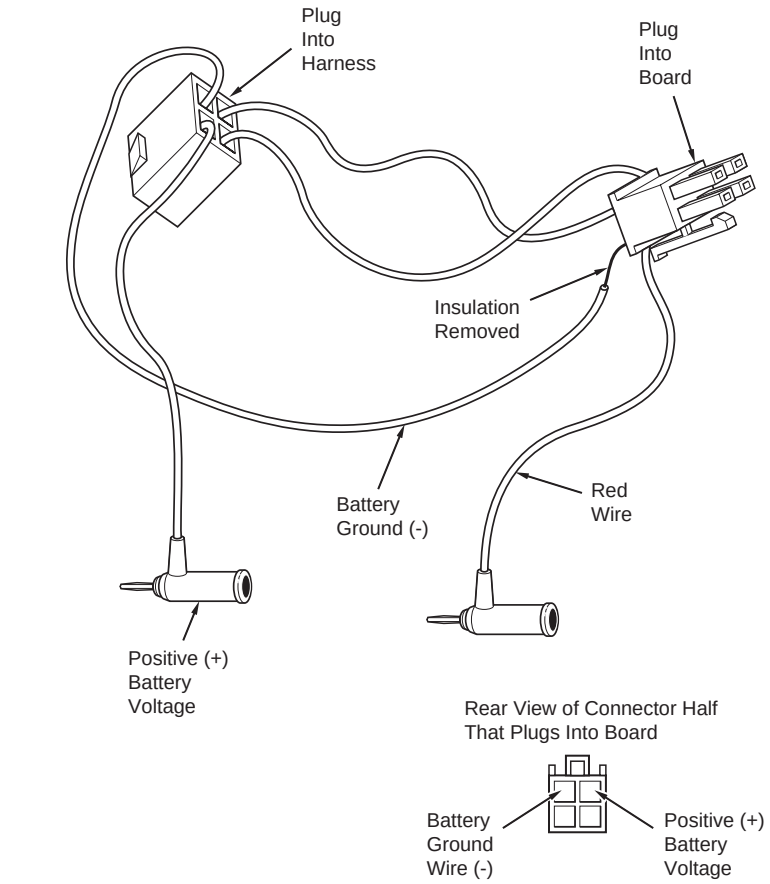


Figure 6-1: Power Test Cable

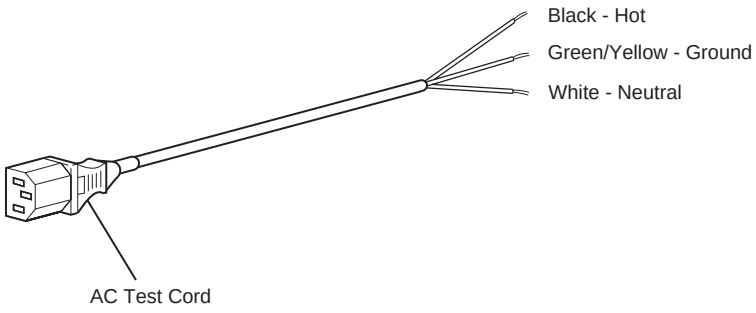


Figure 6-2: AC Input Test Connector

NIBP Calibration

NOTE:

- The NIBP Functionality test is intended for CSI in-house use only.
- Before you proceed any further into the final test of the Scholar III patient monitor you must meet the following conditionst:

— Pressure calibration is to be performed ONLY under the temperature conditions outlined below. Failure to do so may result in pressure calibration errors. After calibration, the calibration reading available on the service screen should remain in the range of ±0.5mmHg, if the monitor has been in the operating temperature range for at least two hours.

— Ensure that the temperature of the NIBP module matches ambient air temperature (defined to be between 19 degrees and 24 degrees C). If power has been applied to the monitor within the last two hours, expose the module to ambient air for one continuous hour with the power turned off. To expose the module to ambient air, it must either be outside of the monitor or you must remove the top of the monitor.

— Bring the NIBP module to mid-range operating temperature. Attach a line cord, verify that the ON/OFF (Power) LED on the front panel is lit, and turn power on to the NIBP module. Leave power applied, with the module still exposed to ambient air at temperature between 19 degrees and 24 degrees C, for not less than fifteen minutes nor more than one hour before proceeding with calibration. To expose the module to ambient air, it must either be outside of the monitor or you must remove the top of the monitor. Replace the top of the monitor after you complete the calibration.

NIBP Module Setup

Equipment Required:

- PC computer configured for use with CSI Service Software
- 507EL serial download cable
- Digital manometer (0.01 resolution or better)
- 700cc dummy cuff
- Plastic tuning tool
- ESD protected workbench
- Dynatech Nevada NIBP Analyzer

1. Connect a serial download cable from the PC serial port to the Scholar III INTERFACE connection. Set the DIN download cable to NIBP/USER
2. Open the service tool on the computer. Select *Start* > *Programs* > *CSI NIBP Service* > *NIBPSvc*. Close the disclaimer dialogue box.
3. Click on *Connection* and select *Options*.
4. Select *COM1* for the port and select *Scholar III 507EL* for the model. Click on *OK*.
5. Click on *Connection* and select *Open in Service Mode*.
6. Press the Scholar III monitor ON/OFF key to start the monitor.
7. Connect a 700cc dummy cuff and manometer to the NIBP fitting on the unit.
8. On the LCD window of the monitor verify that the message *NBP SERVICE TOOL* and the pressure reading appears.
9. Verify that the monitor's serial number appears on the ID box. Click *OK*.
10. Click on the *Calibrate* button to calibrate the NIBP module.
11. Check the cuff pressure as indicated on the service screen of the computer. The cuff pressure should be zero ±1 mmHg. If the zero base point is out of range, the NIBP module must be calibrated.
    If the zero base point is out of range, manually set the NIBP module.

    If the zero base point is within ±1 mmHg of zero, proceed to the next step.
12. To perform the service test for speed, click on the *Speed* button, then click on *Start*. When the unit passes the speed test, press *Done*.
13. To perform the service test for leakage, click on the *Leak* button, then click on *Start*. When the unit passes the leakage test, press *Done*.

14. To perform the service test for inflation safety, click on the *Safety* button, then click on *Start*. When the unit passes the safety test, press *Done*.
15. Turn the monitor off. Click on *Abort* if an error message appears on the computer once the monitor is off.
16. Exit the service program on the computer. Remove the download cable. Click *No* to exit the program; click *Yes* to save the data to a user-specified location.
17. Seal pots R1 & RV1 on the BP Module. Seal pots R86 and R17 on the Scholar III NIBP Board assembly.
18. Using the Dynatech Cufflink simulator, take two sets of readings at 120/80 for the adult mode during a cycle time of one minute. Take two sets of readings at 100/65 for the neonatal mode in the Stat mode.

Calibration for Analog Output

1. Set the ECG simulator for ECG performance 2Hz square wave @ 1mV.
2. Connect and display 1mV ECG on the LCD screen, choose the filter setting: *OFF* and *Lead II* configuration.
3. Use a BNC to BNC cable to monitor the analog output on the oscilloscope.
4. Adjust R112 for 1mV ECG peak on the oscilloscope.
5. Adjust R113 for zero voltage baseline on the oscilloscope.
6. Repeat steps 2 and 3 until both 1mV peak and zero base line are seen simultaneously.
7. Disconnect the BNC cable.
8. Check DB-9 connector for telemetry compatibility. Verify +5V is present at pin 9 of the DB-9 connector.

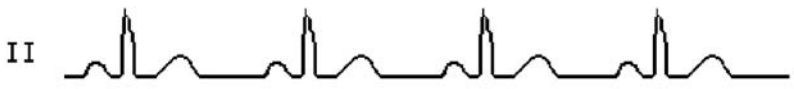
Power Supply Performance

Charger Operation

1. Place unit on your bench. Remove the cover of the Scholar III. Disconnect the power cable, speaker wire, NIBP cable and hose, analog, and DB-9 cables from the Main Board. Flip the bezel upside down and place the component side up. Use the power test cable to connect the board and the base of the 507EL monitor.
2. Insert an ammeter in series with the battery using the power test cable. Measure the quiescent current. Verify that it is less than 0.350mA.
3. Turn the unit on and run it until the battery is drained enough to cause the battery charger to go into bulk charge mode. Plug in the Cat. 924 charger and measure the charge current. The current should be 175 - 350mA.
4. Verify that the green POWER LED illuminates when the Cat. 924 charger is connected to the unit. Remove the Cat. 924 charger and the ammeter.

Verify Centered ECG Baseline

1. Connect the Variable Power Supply to the power test cable.
2. Set the power supply to 12.5VDC.
3. Power up the unit.
4. Insert a CAT 853 (or equivalent) ECG cable into the connector and connect the leads to the ECG simulator.
5. Set the simulator for 60BPM.
6. Press the UP arrow key two times to set the scale to X4.
7. Verify the monitor reads 1/2mV ECG on the X4 scale.
8. Press the DISPLAY key once to enter the ECG only display.
9. Press SETUP to enter *SETUP MENU 1* and verify that *LEAD: II* displays.
10. Set the input filter to *OFF*.
11. Adjust R78 on the ECG/Resp./Temp. Board to center the baseline of the ECG.
12. This is what it looks like when the ECG is centered.



13. Place GLPT or equivalent varnish on R78 of the ECG/Resp./ Temp. Board.

Verify Low Battery

With unit on slowly decrease the Variable Power Supply voltage to 11.70 VDC ±0.2VDC. Verify that the *LOW BATTERY* message appears on the display. There is a long delay before this appears.

Verify Shut off

1. Adjust the Variable Power supply to 11.40VDC.
2. Adjust R92 until the voltage at TP 18 equals 1.3 VDC. GND is at TP 2.
3. Slowly decrease the Variable Power Supply voltage to 10.9VDC ±0.2 VDC, to verify that the unit turns off.
4. Disconnect power from the unit.
5. Assemble unit back to its original configuration. Make sure all cables are connected and every thing is secured and fastened.
6. Place GLPT or equivalent varnish on R92.

Display Check

There should be no intermittence or jittering of pixels. The maximum amount of pixels missing from any display are as follows:

Seven dots are the maximum allowed per screen
Only 1 dot within a 20mm radius circle

Check DB-9 Connector for Telemetry Compatibility

1. Verify +5V is present at PIN 4 f the DB-9 connector. Ground is PIN 5.
2. Install the DB-9 cover.

Set Time and Date

1. With the unit powered up. Press and hold the SETUP key to enter *SETUP MENU 2*.
2. Press the SETUP key to highlight *TIME* and *DATE*.
3. Change them to the current time and date using the UP and DOWN arrows.

Mechnical Inspection

1. Using the steps below, perform a mechanical inspection of the unit.
   a. Ensure that all connectors are secure and locked.
   b. Ensure that all fasteners are in place and secure.
   c. Ensure that the internal pneumatics are correctly routed and secured.
   d. Ensure all internal wiring is correctly routed and secured.
   e. Ensure that all external surfaces are free from defects, scratches, and marks.
2. Place final test sticker on the top of the NIBP MOD PCB AY. bracket.

Section 7 —Disassembly

General Caution

Observe the following caution during all removal and installation procedures in this section.

⚠WARNING⚠

- Possible safety hazard. Read the battery safety information provided in “Introduction” in Section 1

⚠CAUTION⚠

- Static-sensitive device! To prevent damage to the monitor, observe the following precautions:
  a. Perform the procedure on an antistatic mat
  b. Wear a wrist-grounding strap
  c. You should connect both the wrist strap and mat through a resistor (1 megohm typical) to a good earth ground
- Remove the main battery before you perform any service, testing, or maintenance procedures.

Battery Replacement

Battery Removal

1. Follow the caution for static-sensitive devices on page 7-1.
2. Turn the monitor off and disconnect the charger cord from the back of the monitor.
3. Turn the unit upside down and place it on the work surface.
4. Remove the rubber inserts from the feet by pulling the inserts straight up (see "Figure 7-1: Battery Removal"). There is a Phillips-head screw beneath each insert.

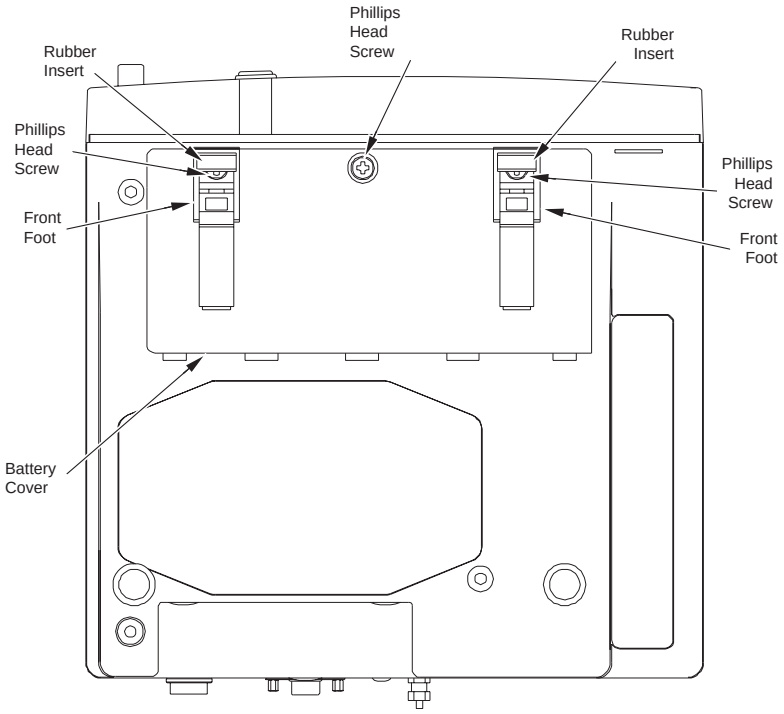


Figure 7-1: Battery Removal

5. Remove the three Phillips-head screws that secure the battery cover to the case.
6. Tilt the battery cover up from the front edge. (use a small screwdriver to gently pry the battery cover open.)
7. Remove the battery cover from the case by lifting it straight up.

⚠CAUTION⚠

- In the next step, be sure you pull only on the battery end of the cable, NOT the end of the cable that is connected to the monitor.

8. To lift the battery out of the battery compartment gently pull on the wires attached to the battery terminals.
9. Release the latch on the battery cable connector then disconnect the battery cable at the connector.

⚠WARNING⚠

- The used battery is a potential environmental hazard and you must dispose of it properly. Refer to the safety instructions in “Introduction” in Section 1

Battery Installation

1. Connect the cable from the new battery to the battery cable connector on the monitor.
2. Position the battery cable so that it does not pinch or pull excessively. Slide the new battery into position in the battery compartment.
3. Replace the battery compartment door and secure it with the three screws. (The short screw goes in the middle.)

   NOTE: When you replace the feet be sure to align the small projection on each foot with the matching depression in the case.
4. Replace the rubber inserts in each foot.
5. Reconnect the power cord to the monitor. Charge the battery for ten hours before you operate the monitor on battery power.

Main Board Replacement

Main Board Removal

1. Follow the caution for static-sensitive devices in “General Caution” on page 7-1.
2. Turn the monitor off. Unplug the AC adapter/charger from the AC wall receptacle. Then unscrew the adapter cord and remove it from the back of the monitor.
3. One of the four Phillips screws that retains the monitor top cover is located beneath the battery (see Figure 7-2). Turn the monitor upside-down. Perform the battery removal procedure at “Battery Removal” on page 7-2.

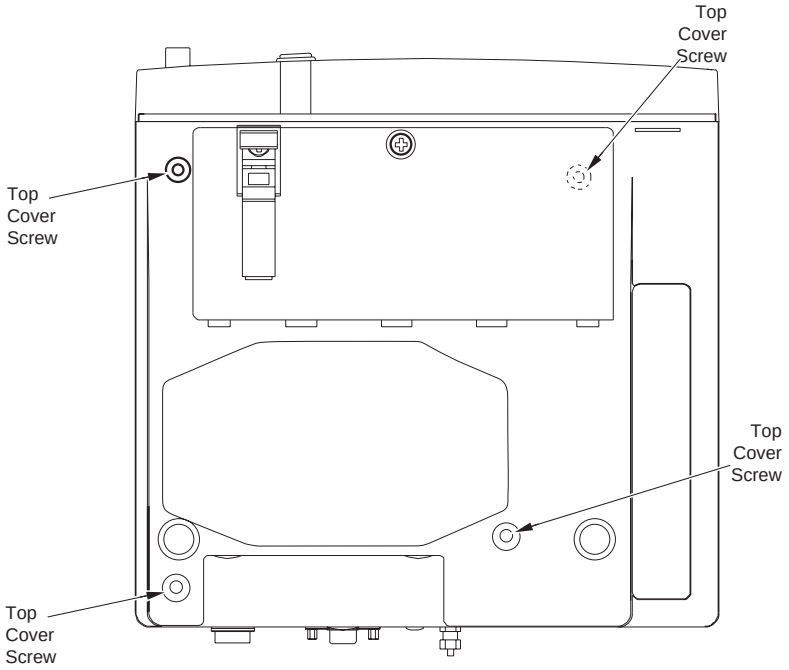


Figure 7-2: Top Cover Removal

4. Remove the Phillips screw located beneath the battery.
5. Remove the other three Phillips screws that are in wells at the corners of the monitor.
6. Turn the monitor right-side up.
7. *507ELC2 monitors only:*
   a. The recorder/printer module of the 507ELC2 is secured in place by one of the top cover screws that were just removed. The module should now be somewhat loose. Detach the module in order to disconnect its cable from the Main Board.
   b. Open the paper door by pressing in on the tab on the rear of the paper door while lifting the door up and forward. It is not necessary to remove the roll of paper.

c. Using a long flat-blade screwdriver, insert the blade into the hole where the tab of the paper door was resting (see "Figure 7-3: Recorder Module Removal"). Press the blade firmly between the module housing retaining tab and the cutout in the top cover of the 507ELC2. At the same time, gently lift up on the module housing. The recorder/printer module should dislodge from the top cover at this time. Close the paper door to prevent the roll of paper from escaping.

NOTE: Do not remove the recorder/printer module before disconnecting the flat flex cable.

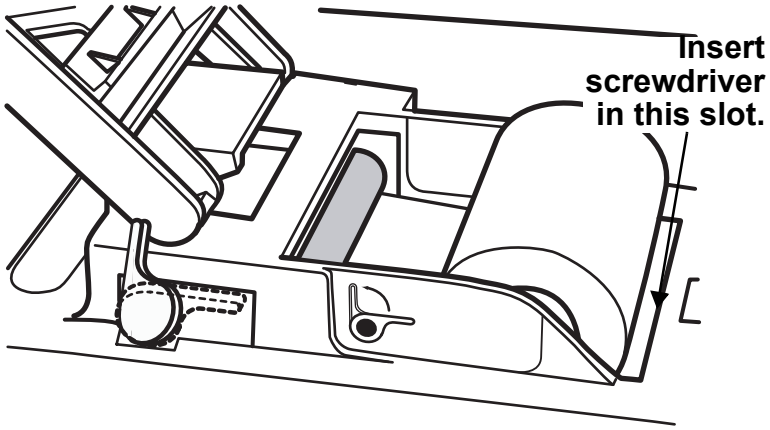


Figure 7-3: Recorder Module Removal

NOTE: The left and right sides of the monitor are the same as the left and right sides of the viewer when you face the front panel of the monitor.

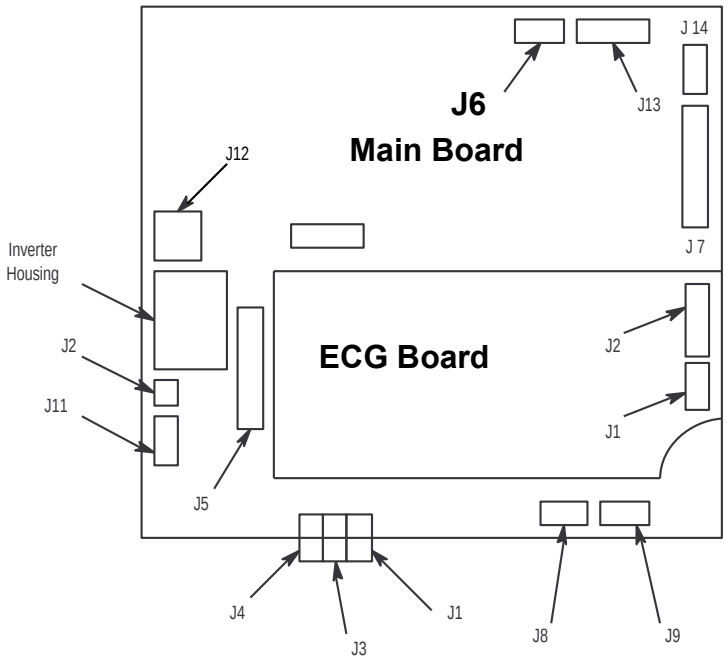


Figure 7-4: Main Board and ECG Board Connectors

⚠CAUTION⚠

- J17 is somewhat delicate. The locking mechanism of J17 is not removable from the body of the connector. Should it detach, it cannot be repaired.

8. 507ELC2 *monitors only:* J17 resides on the Main Board directly beneath the recorder/printer module. Using either the fingers or a small flat-blade screwdriver, gently open J17 by pushing/ pulling the two ears of J17 towards the front of the 507ELC2 until it stops. The flat flex cable from the recorder/printer module can now easily be removed from J17. Place the recorder/printer module aside on an ESD protective surface.
9. Begin to slide the monitor cover upward to remove the cover from the chassis. It may be necessary to use a screwdriver to gently pry upward on the right and left front edges of the cover.
10. Slide the front bezel upward approximately 3/4 inch. Place a small wood block beneath the front bezel to hold it in the raised position so you can unplug the Main Board from the bezel without hitting the Main Board components on objects inside the monitor chassis.

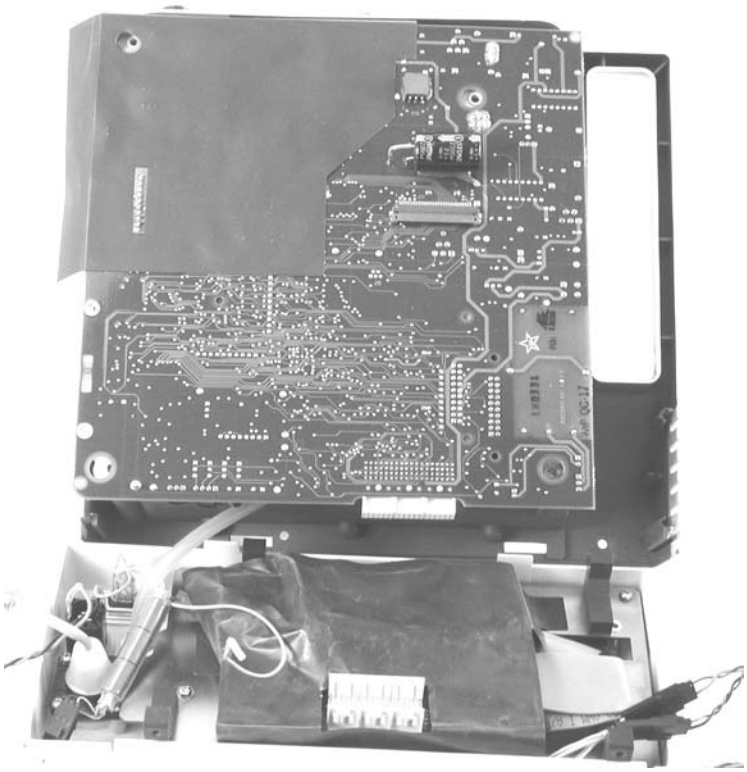


Figure 7-5: Scholar III Open, Main Board Exposed

11. Label and disconnect the ECG connector (J1) and the temperature connector (J2) from the ECG Board (see “Main Board and ECG Board Connectors” on page 7-5).
12. Label and disconnect connectors J8 and J9 (front panel) from the Main Board at the left front of the monitor (see “Main Board and ECG Board Connectors” on page 7-5).
13. On monitors with a recorder, label and disconnect J7 and the connector to the remote battery from the Main Board.
14. Label and disconnect connectors J2 (speaker) and J11 (backlight inverter) from the Main Board. Remove the speaker.
15. Support the Main Board at the front and at the rear. Slide the Main Board backward and away from the front bezel. Label and disconnect connectors J1, J3, and J4. These are located at the front of the Main Board and are connected to the Interconnection Board. (See “Main Board and ECG Board Connectors” on page 7-5.)
16. Label and disconnect the ribbon connector which connects the NIBP assembly to the Main Board at J5. (See “Main Board and ECG Board Connectors” on page 7-5.)

    The Main Board should now be free from the monitor chassis and front bezel. Set the front and rear edges on supports that are raised 1 1/2 inches from the storage surface. The component side of the Main Board must face up to prevent the printer and printer wires from resting on the storage surface and being damaged.

Main Board Installation

1. Slide the front bezel upward approximately 3/4 inch. Place a small wood block beneath the front bezel to hold it in the raised position so you can plug the Main Board into the bezel without hitting the Main Board components on objects inside the monitor chassis.
2. Partially turn the Main Board upside down. Connect the ribbon connector at J5 with the NIBP assembly. Note pin 1.
3. Connect the front panel to Main Board connectors J8 and J9.
4. Connect the front of the Main Board into the front bezel at connectors J1, J3, and J4.
5. Connect connectors J6 (analog output) and J13 (DB-9 connector) at the rear of the Main Board.
6. Connect both connectors (J1 and J2 on the ECG Board) at the left front of the monitor.
7. Connect the power cable connector at J12 of the Main Board.
8. Connect connectors J2 (speaker) and J11 (backlight inverter) on the edge of the motherboard near the speaker. Install the speaker.

9. Remove the wood block from beneath the bezel. Slide the bezel down into the chassis.
10. Slide the top cover down onto the monitor.
11. Turn the monitor upside-down. Install and tighten the four Phillips screws that hold the top cover to the monitor.
12. Perform the battery installation procedure found at “Battery Installation” on page 7-3.
13. On monitors with a printer, start the end of the paper roll into the printer. The paper must feed out from the bottom of the roll because the printer uses a heat activation method of printing and only one side of the printer paper contains a heat sensitive coating. Slide the paper as far as it can go into the printer. Press the PAPER FEED key to thread the paper through the printer (see “Installing Paper Roll” on page 7-12).

Recorder/Printer Replacement

It is not necessary to remove the top cover of the ELC2 to replace the recorder/printer.

NOTE: This applies only to the 507ELC2 models.

Recorder/Printer Removal

1. Follow the caution for static-sensitive devices in “General Caution” on page 7-1.
2. Turn the monitor off. Unplug the AC adapter/charger from the AC wall receptacle. Then unscrew the adapter cord and remove it from the back of the monitor.
3. Turn the monitor upside down and remove only the screw located towards the rear of the monitor on the side of the handle (see "Figure 7-6: Recorder/Printer Module Retaining Screw").

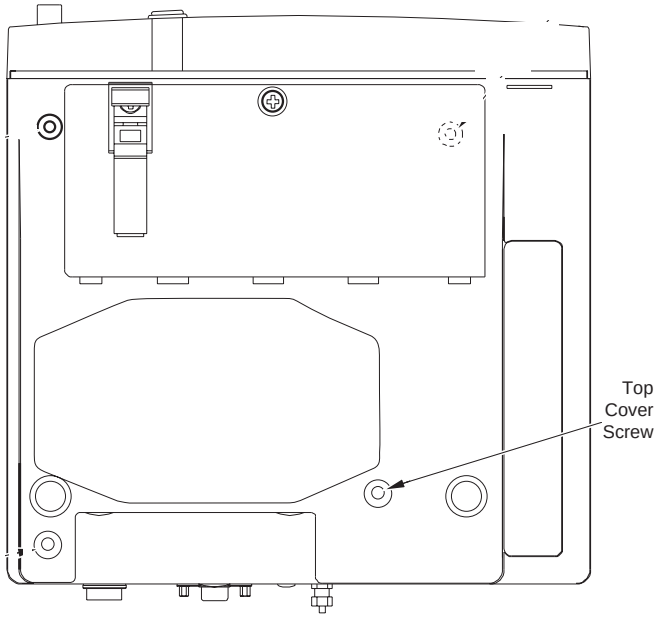


Figure 7-6: Recorder/Printer Module Retaining Screw

4. Turn the monitor right-side up. The recorder/printer module should now be somewhat loose. However, the module must be detached in order to disconnect its cable from the Main Board.

   Open the paper door by pressing in on the tab on the rear of the paper door while lifting the door up and forward. Remove the roll of paper by first raising the paper release lever. Then remove the roll of paper from the chamber.

   NOTE: Do not remove the recorder/printer module before disconnecting the flat flex cable.

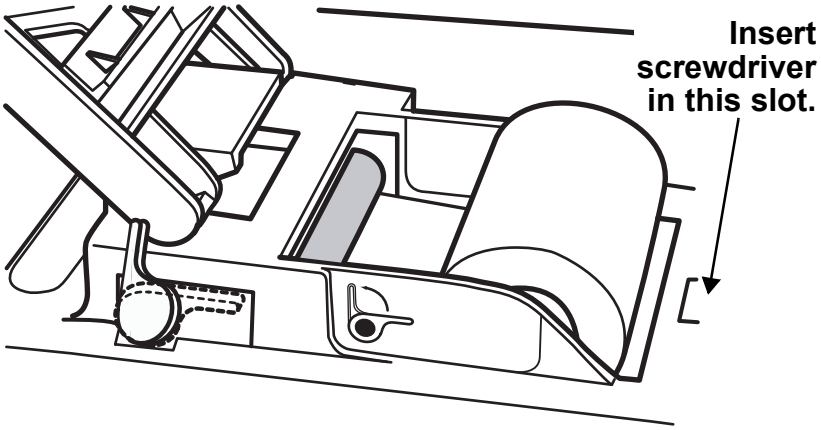


Figure 7-7: Recorder Module Removal

5. Using a long flat-blade screwdriver, insert the blade into the hole where the tab of the paper door was resting (see "Figure 7-7: Recorder Module Removal").Press the blade firmly between the module housing retaining tab and the cutout in the top cover of the 507ELC2. At the same time, gently lift up on the module housing. The recorder/printer module should dislodge from the top cover at this time. Close the paper door to prevent the roll of paper from escaping.

⚠CAUTION⚠

- J17 is delicate. The locking mechanism of J17 is not removable from the body of the connector. Should it detach, it cannot be repaired.

6. J17 resides on the Main Board directly beneath the recorder/printer module. Using either the fingers or a small flat-blade screwdriver, gently open J17 by pushing/pulling the two ears of J17 towards the front of the 507ELC2 until it stops. The flat flex cable from the recorder/printer module will now easily remove from J17. Place the recorder/printer module aside on an ESD protective surface.

Recorder/Printer Installation

1. Follow the caution for static-sensitive devices in “General Caution” on page 7-1.
2. Ensure that the locking mechanism of J17 is in the open position in order that it may accept the flat flex cable from the recorder/printer module. If necessary, pull the locking mechanism forward towards the front of the monitor until it stops.
3. Note the end of the flat flex cable of the recorder/printer module has exposed contacts on one side. The flat flex cable must be installed with this side of the flex cable facing down towards the Main Board of the monitor (that is, contact side down).
4. While holding the recorder/printer module in one hand, insert the flat flex cable (contact side down) into the opened J17 connector. The cable must be inserted all the way into J17 until it stops.
5. Without pulling the flex cable out of J17, gently push forward on the locking mechanism until it snaps closed. This can be tricky.

   NOTE: Ensure that both sides of the locking mechanism are fully closed.
6. Test the flex cable connection by gently tugging on the cable. It must not move in the J17 connector. If it does move or pulls out, then the locking mechanism must be reopened and steps 4, 5, and 6 repeated.
7. Install the recorder/printer module onto the top cover of the monitor by first inserting the front end of the module (the end with the PAPER FEED switch) into the cut out. Allow the back end of the module to rest on the top cover over the cut out.
8. Apply gentle downward pressure on both sides of the rear of the recorder/printer module as it snaps into place on the top cover. The module is loose but is captured by the snap tabs on the module.
9. Turn the monitor upside down. Install and tighten the recorder/printer retaining screw (see "Figure 7-6: Recorder/Printer Module Retaining Screw").
10. Plug the AC adapter/charger into the wall socket. Screw the adapter cord into the monitor.
11. Press the ON/OFF key to power-up the monitor.
12. To install a roll of paper, open the paper door by pressing in on the tab on the rear of the paper door while lifting the door up and forward.

13. Either install the roll previously removed or install a new roll (50 mm paper, CSI cat. no. 1121). New rolls will have a short length of hold-down tape that must be removed from the fresh roll. Ensure that the end of the paper is cut straight. Use scissors, if necessary to square up the end. (Torn paper does not feed correctly.)
14. Ensure the paper release lever on the side of the recorder housing is in the closed (down) position.
15. Ensure that the paper dispenses from the bottom of the roll, as shown below. (See "Figure 7-8: Installing Paper Roll".)

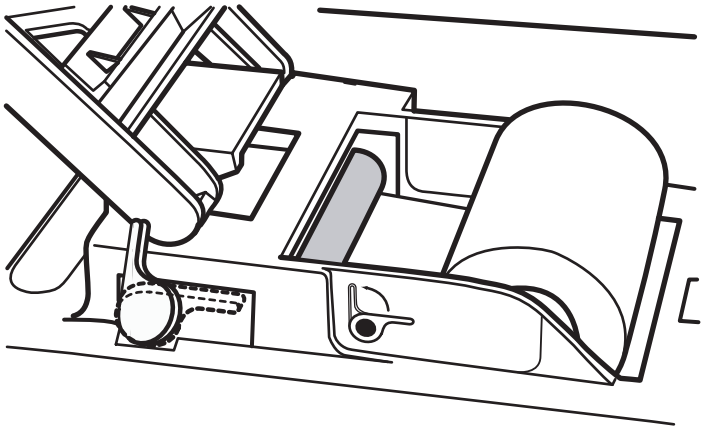


Figure 7-8: Installing Paper Roll

16. Insert the end of the paper squarely beneath the roller of the recorder. If properly inserted, the recorder should begin to Auto Feed after about one second. If this does not occur, then the paper may be manually started.
    a) Raise the paper release lever, inserting the paper beneath the roller,
    b) Lower the paper release lever,
    c) Press the PAPER FEED key located on top of the recorder housing.
17. Center the paper on the roller, if necessary, by using the paper release lever and repositioning the paper.
18. Feed the paper through the slot of the paper door and close the paper door over the new roll of paper.
19. Ensure that the paper door latches shut.

Loudspeaker Replacement

Loudspeaker Removal

1. Follow the caution for static-sensitive devices in “General Caution” on page 7-1.
2. Perform the battery removal procedure at “Battery Removal” on page 7-2.
3. Perform the first 12 steps of the Main Board removal procedure found in “Main Board Removal” on page 7-4.
4. Label and disconnect connector J2 on the Main Board that connect to the speaker (see “Main Board and ECG Board Connectors” on page 7-5).
5. Remove the speaker from the monitor.

Loudspeaker Installation

1. Take the connector for the new speaker and connect it to J2 on the Main Board (see “Main Board and ECG Board Connectors” on page 7-5).
2. Perform the Main Board installation procedure found in “Main Board Installation” on page 7-7.
3. Slide the top cover down onto the monitor.
4. Turn the monitor upside-down. Install and tighten the four screws that hold the top cover to the monitor.
5. Perform the battery installation procedure in “Battery Installation” on page 7-3.

ECG Board Replacement

ECG Board Removal

1. Follow the caution for static-sensitive devices in “General Caution” on page 7-1.
2. Perform the battery removal procedure at “Battery Removal” on page 7-2.
3. Perform the Main Board removal procedure found in “Main Board Removal” on page 7-4.
4. Remove the four plastic screws from the solder side of the ECG board (see “Main Board and ECG Board Connectors” on page 7-5). You must label and disconnect the printer flex cable to expose one of the screws.
5. Label and disconnect the ECG cable at J2 on the ECG Board.
6. Label and disconnect the temperature connector at J1 on the ECG Board.
7. Gently shake and pull up the ECG assembly from the Main Board.
8. To get access to the board-level components, remove the top four nylon screws, then open the shield.

ECG Board Installation

1. Plug the ECG board into the Main Board (see “Main Board and ECG Board Connectors” on page 7-5).
2. Install the plastic screw through the ECG board and tighten it.
3. Perform the Main Board installation procedure found in “Main Board Installation” on page 7-7.
4. Slide the top cover down onto the monitor.
5. Turn the monitor upside-down. Install and tighten the four screws that hold the top cover to the monitor.
6. Perform the battery installation procedure in “Battery Installation” on page 7-3.

Blood Pressure Board Replacement

Blood Pressure Board Removal

1. Follow the caution for static-sensitive devices in “General Caution” on page 7-1.
2. Perform the battery removal procedure at “Battery Removal” on page 7-2.
3. Perform the Main Board removal procedure found in “Main Board Removal” on page 7-4.
4. Remove the four plastic screws from the corners of the Blood Pressure (BP) Board (see Figure 7-8). A plastic spacer is positioned at each screw point, between the circuit board and the metal bracket. Retain the plastic spacers for board installation.

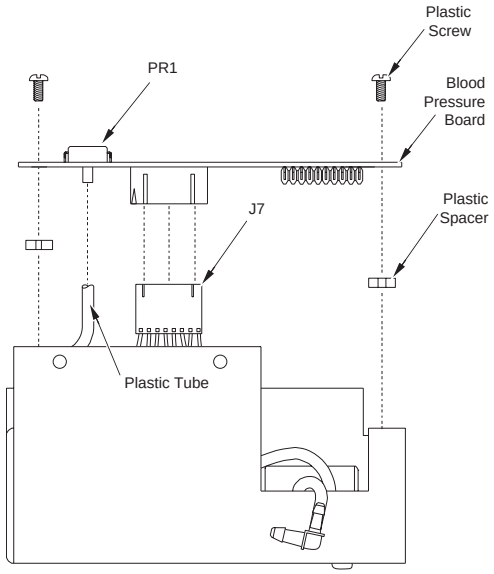


Figure 7-9: Blood Pressure Board Replacement

5. At the rear of the Blood Pressure Board, label and disconnect J7 (an 8-pin connector). Also label and disconnect the plastic tube from PR1, the pressure transducer.
6. Lift the blood pressure board out of the monitor chassis.

Blood Pressure Board Installation

1. Connect the plastic tube onto pressure transducer PR1, at the rear of the new Blood Pressure Board (see “Blood Pressure Board Replacement” on page 7-15).
2. Connect connector J7 into the rear of the new Blood Pressure Board.
3. Place a plastic spacer on each of the four metal mounting brackets.
4. Set the new Blood Pressure Board down onto the plastic spacers. Install the four plastic screws through the board and the plastic spacers and tighten them.
5. Perform the Main Board installation procedure found in “Main Board Installation” on page 7-7.
6. Slide the top cover down onto the monitor.
7. Turn the monitor upside-down. Install and tighten the four screws that hold the top cover to the monitor.
8. Perform the battery installation procedure in “Battery Installation” on page 7-3.

Air Pump Replacement

Air Pump Removal

1. Follow the caution for static-sensitive devices in “General Caution” on page 7-1.
2. Perform the battery removal procedure at “Battery Removal” on page 7-2.
3. Perform the Main Board removal procedure found in “Main Board Removal” on page 7-4.
4. Perform the Blood Pressure Board removal procedure found in “Blood Pressure Board Removal” on page 7-15.
5. Label and disconnect (at the elbow) the plastic hose that extends to the Quick-Connect fitting on the display panel (see Figure 7-9).

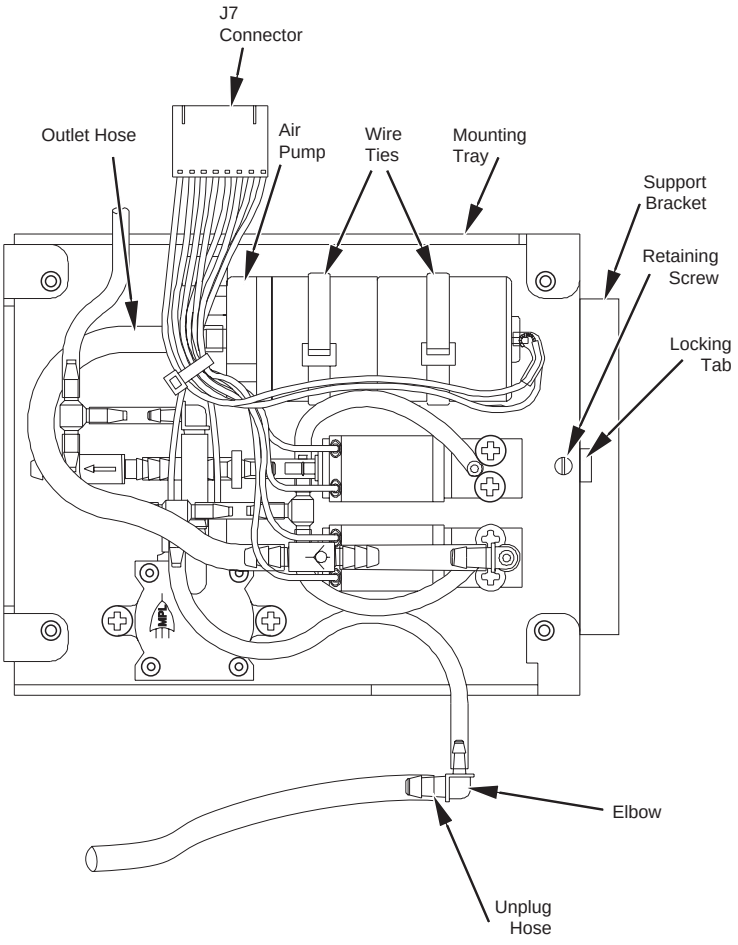


Figure 7-10: Air Pump Installation

6. Remove the retaining screw that holds the mounting tray to its support bracket.

7. Lift slightly the open end of the mounting tray until it clears the locking tab on the support bracket. At the same time, slide the tray toward the locking tab until the tray pulls free of the two other tabs that hold the tray to the support bracket. Lift the tray out of the monitor.
8. Cut the two wire ties that hold the air pump to the mounting tray.
9. Label and disconnect the outlet hose from the plastic nipple in the center of the air pump.
10. The two wires that supply the air pump are plugged into the J7 connector. If the pump is being replaced, the two wires must be removed from this connector (see Figure 7-10). To free the pump wires, first remove the wire tie from the harness that contains them.
11. Use a thin object with a fine point (e.g., a very small screwdriver) to depress the latch on the female terminal end while pulling gently on the wire to remove it from the J7 connector.

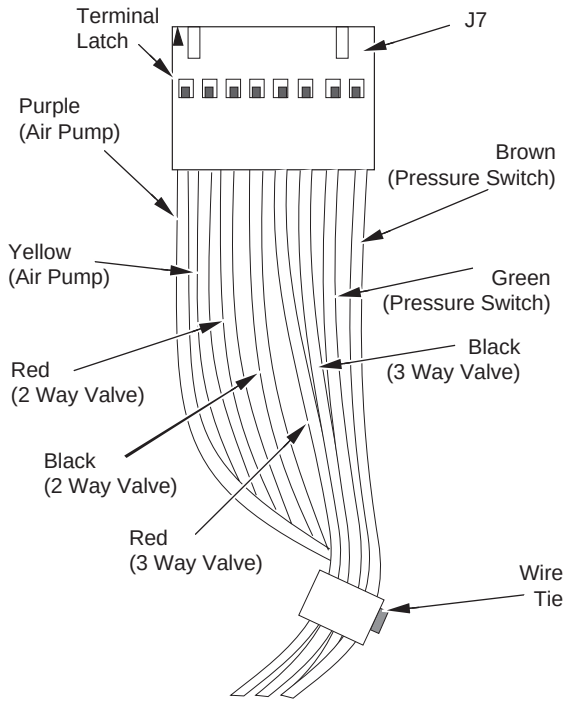


Figure 7-11: Wire Position and Removal from J7 Connector

Air Pump Installation

1. Install the two wire ties through the slots in the bottom of the mounting tray (see “Air Pump Installation” on page 7-17).
2. Slide the terminal end of each pump wire into connector J7 until the terminal latch locks into its slot (see “Wire Position and Removal from J7 Connector” on page 7-18). Be certain that the purple wire is in the first position in the J7 connector and that the yellow wire is in the second position.
3. Plug the outlet hose onto the plastic nipple at the center of the pump.
4. Set the pump onto the vibration damping pad and tighten the wire ties around the pump.
5. Install a new wire tie around the wire harness.
6. Pick up the mounting tray and set it onto the support bracket so that the two tabs at the rear of the bracket slide into the slots on the tray.
7. Press down on the open end of the tray until the edge of the tray locks behind the tab on the support bracket.
8. Install the screw that holds the mounting tray to the support bracket.
9. Plug the hose from the display panel onto the elbow that leads to the solenoid valves.
10. Perform the Blood Pressure Board installation procedure found in “Blood Pressure Board Installation” on page 7-16.
11. Perform the Main Board installation procedure found in “Main Board Installation” on page 7-7.
12. Slide the top cover down onto the monitor.
13. Turn the monitor upside-down. Install and tighten the four screws that hold the top cover to the monitor.
14. Perform the battery installation procedure in “Battery Installation” on page 7-3.

Solenoid Valve Replacement

General

Two solenoid valves in the air system control the blood pressure cuff inflation and deflation. (See "Figure 7-12: Solenoid Valve and Pressure Switch Installation".) The same installation and removal procedures can be used for both valves.

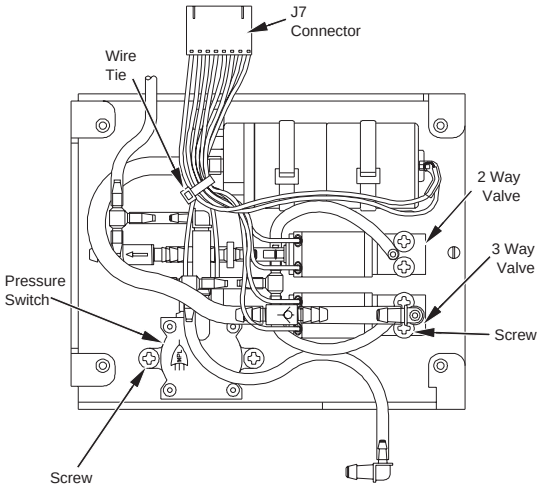


Figure 7-12: Solenoid Valve and Pressure Switch Installation

Solenoid Valve Removal

1. Follow the caution for static-sensitive devices in “General Caution” on page 7-1.
2. Perform the battery removal procedure at “Battery Removal” on page 7-2.
3. Perform the Main Board removal procedure found in “Main Board Removal” on page 7-4.
4. Perform the Blood Pressure Board removal procedure found in “Blood Pressure Board Removal” on page 7-15.
5. Label and disconnect the plastic tubes from the valve.
6. To remove the valve from the monitor you must remove the two wires from the J7 connector that supply the valve. Free the wires from the harness that contains them by clipping the wire ties that hold the harness together (see “Air Pump Installation” on page 7-17).
7. Label the connector at J7. Use a thin object with a fine point (e.g., a very small screwdriver) to depress the latch on the female terminal end and pull gently on the wire to remove it from the J7 connector. Be sure to note the positions of the red and black wires in the connector before removing them. You must return the wires to the original positions when you reassemble.

8. Remove the screws from the valve block. Retain the plastic spacer that is beneath each screw. The spacers are used for reassembly. Lift the solenoid valve out of the monitor.

Solenoid Valve Installation

1. Plug the hoses onto the valve (see “Solenoid Valve and Pressure Switch Installation” on page 7-20).
2. Set the valve into position in the monitor.
3. Apply Loctite 425 (CSI Cat. No. 41157B001) to the valve retaining screws. Insert the screws into the valve block. Place a plastic spacer beneath each screw. Tighten the screws.
4. Slide the terminal ends of the valve wires into connector J7 (“Wire Position and Removal from J7 Connector” on page 7-18).

   Be sure that the terminal latch on each wire locks into its slot. Be sure that all wires are in their original positions in the connector.
5. Install new wire ties on the wire harness.
6. Perform the Blood Pressure Board installation procedure found in “Blood Pressure Board Installation” on page 7-16.
7. Perform the Main Board installation procedure found in “Main Board Installation” on page 7-7.
8. Slide the top cover down onto the monitor.
9. Turn the monitor upside-down. Install and tighten the four screws that hold the top cover to the monitor.
10. Perform the battery installation procedure in “Battery Installation” on page 7-3.

Pressure Switch Replacement

Pressure Switch Removal

1. Follow the caution for static-sensitive devices in “General Caution” on page 7-1.
2. Perform the battery removal procedure at “Battery Removal” on page 7-2.
3. Perform the Main Board removal procedure found in “Main Board Removal” on page 7-4.
4. Perform the Blood Pressure Board removal procedure found in “Blood Pressure Board Removal” on page 7-15.
5. Two wires supply the pressure switch (see “Solenoid Valve and Pressure Switch Installation” on page 7-20). To remove the pressure switch you must unplug these wires from the J7 connector. First clip the wire tie that holds the pressure switch wires in the wire harness (see “Wire Position and Removal from J7 Connector” on page 7-18).
6. Label the connector at J7. Use a thin object with a fine point (e.g., a very small screwdriver) to depress the latch on the female terminal end and pull gently on the wire to remove it from the J7 connector. Be sure to note the positions of the red and black wires in the connector before removing them. You must return the wires to the original positions when you reassemble.
7. Remove the two screws that hold the pressure switch in place.
8. Label and remove the hose from the pressure switch. Remove the pressure switch from the monitor.

Pressure Switch Installation

1. Plug the hose onto the plastic nipple on the pressure switch.
2. Set the pressure switch down into position in the monitor.
3. Apply Loctite 425 (CSI Cat. No. 41157B001) to the switch retaining screws.
4. Slide the screws through the switch and thread them into the mounting tray.
5. Slide the terminal end of each switch wire into the J7 connector until the terminal latch locks into its slot (see “Wire Position and Removal from J7 Connector” on page 7-18). Be certain that the switch wires are in their original positions in the J7 connector.
6. Perform the Blood Pressure Board installation procedure found in “Blood Pressure Board Installation” on page 7-16.
7. Perform the Main Board installation procedure found in “Main Board Installation” on page 7-7.
8. Slide the top cover down onto the monitor.

9. Turn the monitor upside-down. Install and tighten the four screws that hold the top cover to the monitor.
10. Perform the battery installation procedure in “Battery Installation” on page 7-3.

Display Interface Board and 7-segment LED Board Replacement

Front Bezel Removal

1. Follow the caution for static-sensitive devices in “General Caution” on page 7-1.
2. Perform the procedure in “Battery Replacement” on page 7-2.
3. Perform the Main Board removal procedure in “Main Board Replacement” on page 7-4.
4. Disconnect the grounding connector lead to the front bezel assembly.
5. Unplug at the elbow, the hose that runs to the Quick-Connect fitting for the blood pressure cuff on the front bezel (see Figure 7-11).
6. Disconnect the temperature cable, the ECG cable, the SpO2 cable, and the backlight cable. Mark each cable so that it can later be properly reconnected.
7. Remove the loudspeaker from the monitor chassis.
8. Remove the four Phillips screws that hold the bezel to the chassis—two at the top and two at the bottom. (See "Figure 7-13: Remove the Front Bezel".)

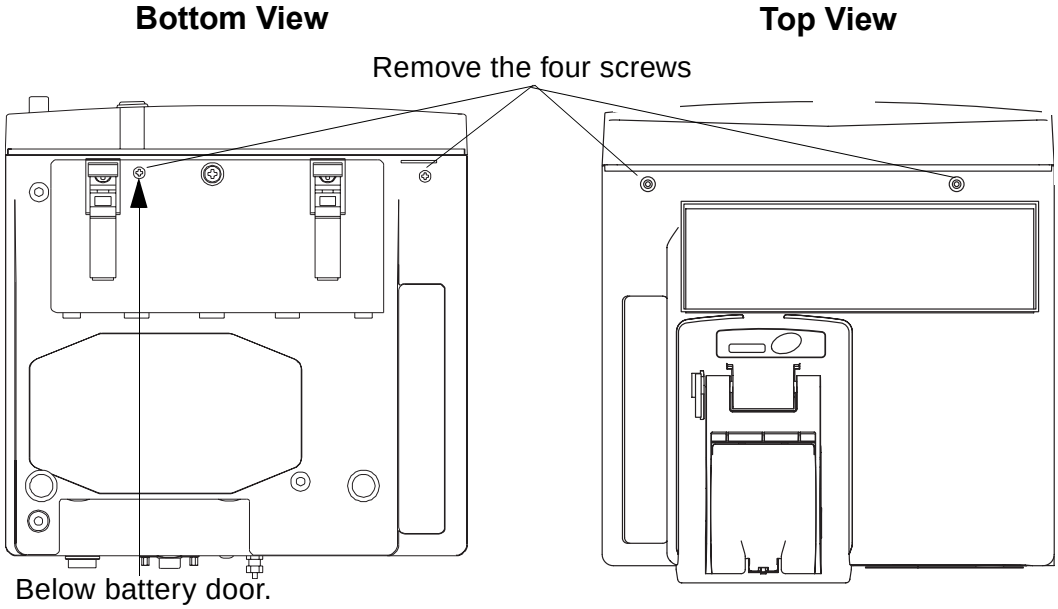


Figure 7-13: Remove the Front Bezel

9. Slide the front bezel upward and out of the monitor chassis.

Display Interface Board and 7-segment LED Board Removal

1. Follow the caution for static-sensitive devices in “General Caution” on page 7-1.
2. Perform the battery removal procedure at “Battery Removal” on page 7-2.
3. Perform the Main Board removal procedure found in “Main Board Removal” on page 7-4.
4. Label and disconnect the grounding connector lead to the front bezel assembly.
5. Label and disconnect (at the elbow) the hose that runs to the Quick-Connect fitting for the blood pressure cuff on the front bezel. (See "Figure 7-14: Disconnecting Blood Pressure Cuff Hose at Elbow".)

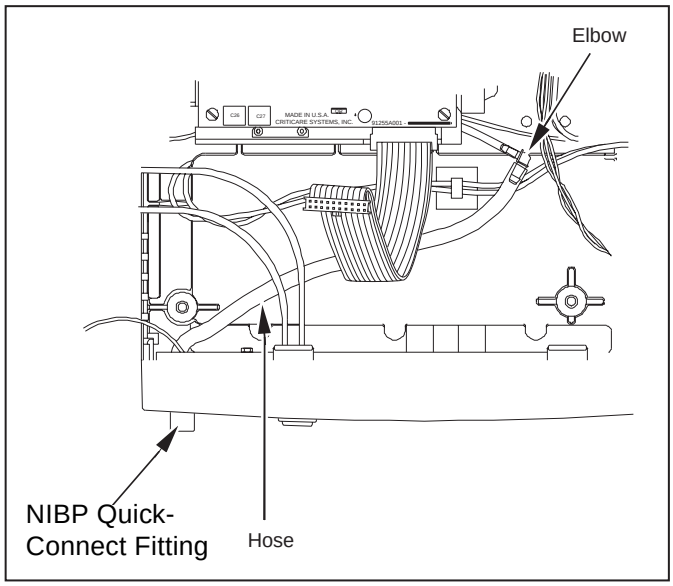


Figure 7-14: Disconnecting Blood Pressure Cuff Hose at Elbow

6. Label and disconnect the temperature cable, the ECG cable, the SpO_2 cable, and the backlight cable.
7. Remove the speaker from the monitor chassis.
8. Slide the front bezel upward and out of the monitor chassis.
9. Remove the two nuts that hold the EMI shield to the Display Interface Board (see “Front Bezel Assembly” on page 7-27).
10. Remove the four screws that secure the EMI shield to the Display Interface Board. Remove the EMI shield from the Display Interface Board.

11. Label the cable connected to P7. Reach underneath the edge of the Display Interface Board near the P7 header connector and gently lift upward until P7 unplugs. As a single unit, lift the Display Interface Board and the 7-segment LED board out of the front bezel.
12. To separate the 7-segment LED Board from the Display Interface Board, label and disconnect the header connectors marked P1and P2 on the Display Interface Board.

Display Interface Board and 7-segment LED Board Installation

1. Join the 7-segment LED Board with the Display Interface Board by plugging together the header connectors marked P1 and P2 on the Display Interface Board (see “Front Bezel Assembly” on page 7-27).
2. Set the assembled boards into the front bezel. Carefully align the pins and then plug the P7 header connector on the Display Interface Board into the header block inside the front bezel.
3. Install and tighten the four screws that hold the Display Interface Board to the threaded supports inside the front bezel.
4. Set the EMI shield down onto the Display Interface Board. The top and bottom edges of the shield must fit inside the front bezel. Install the two screws that hold the shield to the Display Interface Board.
5. Slide the front bezel down into the monitor chassis.
6. Set the loudspeaker into position inside the monitor chassis.
7. Plug the hose from the blood pressure cuff fitting onto the elbow that extends out of the mounting tray (See “Disconnecting Blood Pressure Cuff Hose at Elbow” on page 7-25).
8. Perform the Main Board installation procedure found in “Main Board Installation” on page 7-7.
9. Slide the top cover down onto the monitor.
10. Turn the monitor upside-down. Install and tighten the four screws that hold the top cover to the monitor.
11. Perform the battery installation procedure in “Battery Installation” on page 7-3.

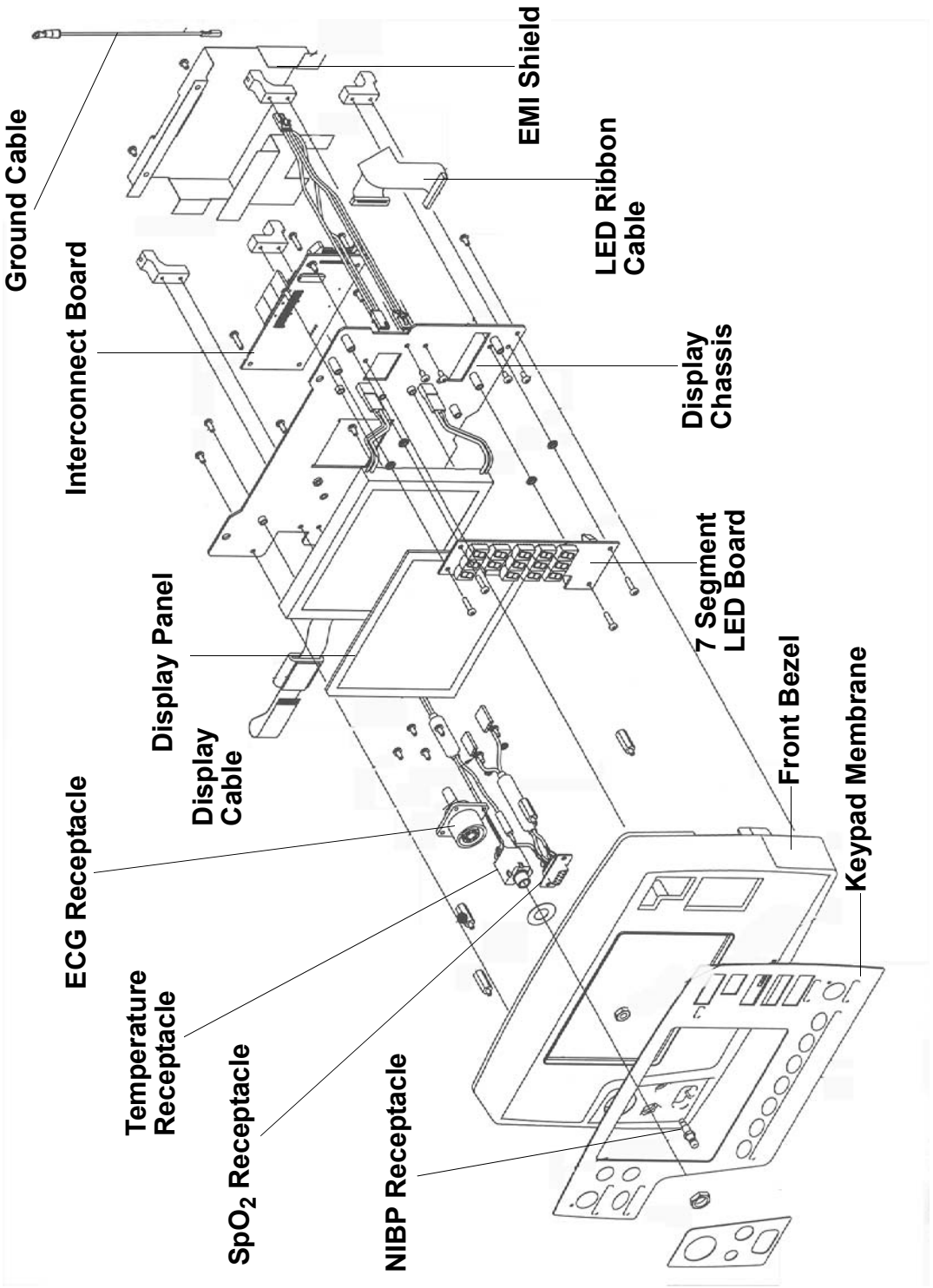


Figure 7-15: Front Bezel Assembly

Keypad Membrane Replacement

General

If any of the keys on the front of the monitor fail to operate, you must replace the membrane that contains the keys.

The keypad membrane also contains the following LEDs:

- Lights for ALARM SILENCE (red) and ON/OFF (Power; green) and
- 7-segment numeric displays for BPM (red), SpO_2% (green), and NIBP (red) for SYS mm Hg, DIA mm Hg, and Mean mm Hg.

If it becomes necessary to replace one of these LEDs, it is necessary to replace the entire keypad membrane. The keypad membrane contains all the LEDs identified in this paragraph.

Keypad Membrane Removal

1. Follow the caution for static-sensitive devices in “General Caution” on page 7-1.
2. Perform the Display Interface Board and LED Board removal procedure found in “Display Interface Board and 7-segment LED Board Removal” on page 7-25.
3. On the front side start at the upper left corner of the front bezel and use a thin blade to get beneath the plastic membrane. After you lift the corner of the membrane pull with your fingers to peel the entire membrane off the front of the bezel.
4. Put some denatured alcohol on a clean cloth to clean any places on the front bezel where glue remains from the membrane that you removed.

⚠CAUTION⚠

- Be certain that the bezel is completely dry before installing a new keypad membrane. The solvent can damage the traces on the backside of the new membrane.

Keypad Membrane Installation

1. Follow the caution for static-sensitive devices in “General Caution” on page 7-1.
2. Peel the backing sheet from a new keypad membrane to expose the glued surface on the back of the membrane.
3. Carefully align the connector block on the membrane and the LEDs on the membrane with the openings in the front bezel. Press down on all areas of the membrane to make sure that the glue has made a strong and complete bond with the bezel.

4. Install the Display Interface Board and LED boards by performing the “Display Interface Board and 7-segment LED Board Installation” on page 7-26.

SpO_2 Sensor Receptacle

General

If the SpO_2 sensor receptacle is defective you must replace the front bezel (see “Wire Position and Removal from J7 Connector” on page 7-18). A new bezel contains a new SpO_2 sensor receptacle and a new keypad membrane.

To replace the bezel, perform the Display Interface Board and LED Board removal procedure (found in “Display Interface Board and 7-segment LED Board Removal” on page 7-25) on the old bezel. Then install the boards into the new bezel, by performing the Display Interface Board and LED Board installation procedure found in “Display Interface Board and 7-segment LED Board Installation” on page 7-26.

Section 8 — Troubleshooting

Troubleshooting Table

This section lists the possible causes of monitor problems. Use these tables and the schematics in "Drawings and Schematics" in Section 9 to identify and locate components that malfunction.

Symptom	Problem	Solution
Unit won't power up	• Battery is discharged	Connect AC charger
	• AC charger is not securely connected to monitor	Connect charger cord securely to rear panel connector
	• AC power cord is not securely connected to charger	Connect cord to charger
	• AC outlet is not "live"	Connect the power cord to a live outlet
	• Fuses F1 and/or F2 (on Main Board) are blown	Replace fuses
	• J12 on Main Board is disconnected	Connect J12
	• J1, J3, J4, and/or J11 on Main Board are disconnected or loose	Connect J1, J3, J4, and/or J11
Leaks in NIBP system	• NIBP cuff connector is loose at front panel	Tighten connector
	• Defective cuff	Replace cuff
	• Defective hose	Replace hose
NIBP not functioning	• NIBP module is not communicating with Main Board	Power unit off, then on while watching the display. If the screen is blank for ten seconds after the logo displays, the NIBP module is not communicating with the Main Board. Check for the following: • A good connection at J8 on the NIBP Board • Flash PROM U27 is completely seated in socket • Good connection at each end of ribbon cable between Main Board J5 and NIBP module J8
No sound from speaker	• J2 on Main Board is disconnected or loose	Connect J2
	• Speaker wire broken at speaker terminals	Check speaker wires
Display backlight doesn't work	• J11 on Main Board is disconnected or loose	Connect J11
Display is blank or not readable	• Contrast is misadjusted	Adjust display contrast in *Setup* menu
	• J1, J3, and/or J4 on Main Board are disconnected or loose	Connect J1, J3, and/or J4

Symptom	Problem	Solution
RS-232 interface doesn't work	• Cable to DB-9 connector on rear panel is disconnected or loose • J13 on Main Board is disconnected or loose	Connect cable Connect J13
LEDs don't come on	• LEDs are turned off in software	Enter *Setup* menu, set LEDs to *ON*. (Refer to Operator's Manual)

Troubleshooting and Repair

Before attempting to repair a damaged monitor the technician must fully understand the functions of the monitor. The service technician should have read and understood all the previous sections of this manual.

You must fully repair, calibrate, and test all damaged monitors before you use them on patients. The monitor must meet the original operating specifications before you use it on a patient.

Always follow ESD precautions when performing any of the procedures discussed in this section.

ComfortCuff NIBP Module

The NIBP module (pn 93755A005) consists of a pneumatic pump assembly (pn 90772A001) and control circuitry located on the NIBP Board (pn 91255A005).

The pneumatic assembly is mounted on a mounting plate that is mounted to the frame of the monitor. A large diameter tube (pn 41700B002) connects to the Quick-Connect hardware fixture. A small diameter tube (pn 41700B001) connects to the transducer on the NIBP Board.

The remaining pneumatics links connect the two control valves (pn 90774A001 and 90775A001), the pump (pn 84500B001), and the check valve (pn 41579B003). As the tubing ages it may lose its seal. Old tubing can be re-seated or replaced as necessary.

When any major pneumatic component such as a pump or valve is replaced, the NIBP module must be re-calibrated as in "Service Testing and Calibration" in Section 6 of this manual. The manufacturer recommends that the monitor be returned to a CSI authorized service facility if pump replacement is required.

ECG/Respiration/ Temperature Module

The ECG module is located on the ECG-Resperation-Temperature Board assembly (pn 91295A001) that is attached to the Main Board.

The ECG-Resp.-Temp. Board fits directly on to the Main Board through a socketed 20-pin connection on the component side of the Main Board assembly. There is also a shielded cable assembly that extends from the top of the board to the external ECG port. Check each of these connection points if the monitor fails to produce an accurate ECG waveform.

The ECG-Resp.-Temp. Board has a foil shield to reduce noise from other portions of the monitor. Noise can be introduced by worn cable assemblies and degraded power supplies. Test the analog ECG waveform signal and the input power where they enter the ECG-Resp.-Temp. Board for interference noise.

You can replace the ECG-Resp.-Temp. Board as an assembly with the Main Board as a serviceable component. Replacement Main Board/ECG-Resp.-Temp. Board assemblies, (pn 95536A002) are pre-tested, software loaded, and calibrated. The monitor requires complete safety testing after reassembly.

NOTE: Always check line frequency, filter settings and the ECG lead cables as part of any ECG trouble shooting. Always use the recommended simulators for performance testing.

Board Settings and Module Software

There is one pot under the shielding at locations R78. This is factory set and should not be adjusted.

Respiration

The respiration circuit is located on the ECG-Resp.-Temp. Board. There is no separate calibration or testing for the impedance respiration.

Temperature

The temperature module is located on the ECG-Resp.-Temp. Board. There are no on-board settings or service calibrations. The temperature module is auto-calibrating upon start-up.

DOX SpO_2 Module

The DOX SpO_2 module is included on the Main Board.

The plethysmograph input signal enters the Main Board through a shielded cable that runs between the board and the SpO_2 connection on the front of the monitor.

The DOX SpO_2 module is composed of digital components that are not effected by noise. There is also no signal degradation or loss of calibration due to analog components. Interference or noisy signal can be due to a worn cable assembly or DB-9 connector. Replace the connector and cable assembly if necessary.

Always check the sensor when intermittent problems are reported. Stretched or otherwise damaged sensor cables must be replaced.

NOTE: The line frequency setting of the monitor must be set correctly for optimal SpO_2 monitoring.

Main Board

The Main Board (pn 91369A001) contains the primary processors, storage memory, NIBP circuitry, communication interfaces, audio driver, vital signs module connections, power regulation, and video generation and keypad inputs (User I/O).

The main ground cable (pn 95637A001) and the display ground cable (pn 95642A001) are part of the Main Board assembly.

There are two CPUs on the Main Board that you must program from a CSI Service Download Station. The programmable settings remain in non-volatile memory. Repair or improper handling of the Main Board can corrupt this software. See procedure 91340T003 for more information.

There is one replacable 3-amp fuse (pn 82004B001) for the battery input at F1. There is one replaceable fuse (pn 82003B001) for the power supply module at F2.

CAT 924 Battery Charger

The CAT 924 Battery Charger (pn 90250A001) consists of of a transformer, a fixed cord that attaches to the 507ELC2 monitor, and a detachable cord that plugs into the wall. The detachable cord should be correct for your country's power grid. If you have the wrong cord, contact Criticare Systems for the correct cord.

The transformer box is not field reparable. If the transformer has failed, return it to Criticare.

Replace broken, cracked, or loose AC receptacles. Replace the receptacle if the external pins are bent or broken. Do not attempt to remove or modify the ground pin!

Check the transformer and cables for damage before replacement. Measure the icoming and outgoing voltages and assure they match the specifications printed on the transformer box.

Section 9 — Drawings and Schematics

List of Drawings

Title	Drawing Number
Final Assembly	93971A001
Front Bezel-Active	92522A001
Chassis Assembly	92791A001
Main/ECG-Resp-Temp Assembly	95722A001
NIBP Assembly	93755A005
NIBP Mounting Base	93251A002
NIBP Valve-Pump Assembly	91753A002
NIBP Valve/Switch Assembly	91754A002
Printer/Recorder Assembly	95721A001
Main Board PCB	91369A003
Main Board Schematic	91369S003
ECG-Resp-Temp Daughter PCB	91295A001
ECG-Resp-Temp Daughter PCB Schematic	91295S001
NIBP PCB	91255A005
NIBP PCB Schematic	91255S005
Interconnection PCB	91367A001
Interconnection PCB Schematic	91367S001
LED Display PCB	91366A001
LED Display PCB Schematic	91366S001

Final Assembly

93971A001 FINAL AY 507ELC2

Item #	CSI Part #	Description
01	40496B001	P.H.M.S. 6-32X.375 SEMS
05	45006B004	COVER 507EL
09	95723A001	LABEL SET 507ELC2 ENG
11	46036B101	LABEL QLTY SEAL CSI LOGO
13	92791A001	AY CHASSIS SCHOLAR III
16	40180C007	F.H.M.S. COATED COOL GRAY
17	41891B001	DB9 COVER PLATE
18	40995B005	P.H.M.S. 4-40X.25 SEMS
20	46162B001	LABEL CSI MON BAR CODE
21	40065B002	PAPER THERMAL 2.283 WIDE
22	92522A001	AY BEZEL SCHOLAR III ACT
23	95722A001	AY MAIN /ECG-TEMP 507ELC2
24	90815A001	AY CABLE 4 WIRE EMI CHOKE
27	42324B001	BACK COVER PLATE 507EL
28	42065B002	F.H.M.S 4-40 X.250 PH PNT
29	40296B002	TUBING SILC BLU .125X.250
30	95721A001	PRINTER AY 507ELC2
31	40496B004	P.H.M.S. 6-32X.500 SEMS

Front Bezel-Active

92522A001 AY BEZEL SCHOLAR III ACT

Item #	CSI Part #	Description
01	45141B001	FRONT BEZEL 507EL
02	45142B001	MEMBRANE 507EL
03	46333B001	LBL FRNT CONN 507EL
04	81518B001	DISPLAY FILTER ACTIVE
05	42322B001	DISPLAY CHASSIS ACTIVE
07	83401B001	EMI SHIELD INTERCONNECT
08	42323B001	MOUNTING BLOCK 507EL
09	91366A001	AY PCB LED DISPLAY 507EL
10	91367A001	AY PCB INTERCONNECT 507EL
11	40995B003	P.H.M.S. 4-40X.500 SEMS
12	83402B001	FLEX CBL NEC DISPLAY ACT
13	83400B001	RIBBON CBL SAMTEC FFSD
14	90899A001	AY CBL 507EL GROUND
15	40284B002	NUT 6-32 KEPS PL
16	90900A001	AY CBL 507EL SPO2/TEMP
18	42014B001	FITNG, QUICK CON. HH NIBP
19	40284B005	NUT 10-32 KEPS PL
20	42384B001	STANDOFF 4-40 X .625 M/F
22	40086B001	WASHER FLAT PL .125X.219
23	41458B001	P.H.M.S. 4 X .250 HI/LO
24	40995B005	P.H.M.S. 4-40X.25 SEMS
25	42335B001	METRIC PAN HEAD M3X8
26	81517C001	DISPLAY NEC MODIFIED
27	42237B001	NUT NYLON JAM 3/8 X 32
28	42236B001	WASHER MYLAR 3/8 .015THK
29	90793A002	AY CABLE ECG 507E
30	90901A001	AY CBL BACK LIGHT NEC
31	42352B001	DRIP GUARD MEMBRANE TAIL
32	42353B001	SHOULDER WASHER #4
33	82550B001	FERRITE FLST CABLE
34	41955B001	FOAM TAPE 1.0 X 2.12

Chassis Assembly

92791A001 AY CHASSIS SCHOLAR III

Item #	CSI Part #	Description
01	40995B001	P.H.M.S. 4-40X.312 SEMS
02	40182B002	MTG HARDWARE SUB-D SILVER
03	40281B007	P.H.M.S. 6-32X.375 PL PH
04	40284B002	NUT 6-32 KEPS PL
05	40496B004	P.H.M.S. 6-32X.500 SEMS
06	41438B001	CLIP TUBING
07	41525B001	SPRING LOC FOLDING LEG
08	41527B001	FEET ADHESIVE HEMISPHERE
09	41537B001	FOAM DISK 1.38 DIA .25THK
10	41537B002	FOAM DISK 1.38 DIA .12THK
11	41592B001	RIVET SNAP BLK K236
12	41691B001	BRACKET MTG 507N NIBP
13	45005B004	CHASSIS FOR 507EL
14	90755A001	AY CABLE 1100 NIBP RIB
15	90798A002	AY CABLE DB-9 SCHOLAR II
16	90796A001	AY CABLE PWR INTFC 507E
17	92250A001	AY BATT MODEL 602-10/11
19	93250A001	AY BATTERY DOOR POET TE
20	93755A005	AY FNL NIBP MOD KEYED
21	95002A002	AY CBL AC CHRGR W/CN 507E
22	95250A001	AY SPEAKER MODEL 602-10/1
28	90813A001	AY CABLE ANALOG OUT 507E
29	80122B001	SOCKET DB-9 PNL MT
30	40119B001	RECEPT BNC IS0 PNL MT
31	40041B007	TUBING SHRINK .062 CLR
35	40041B003	TUBING SHRINK .125 CLR
36	40041B001	TUBING SHRINK .250 CLR

Main/ECG-Resp-Temp Assembly

95722A001 AY MAIN /ECG-TEMP 507ELC2

Item #	CSI Part #	Description
01	40123B004	P.H.M.S. 4-40X.250 NY WHT
02	40557B009	SPACER HEX 4-40X.75L NY
03	41647B003	SPCR HEX 4-40X.500 M/F NY
04	41785B001	SHIELD ECG 507E
05	41786B001	SHIELD OXIMETER 507E
06	91369A003	AY PCB MAIN BOARD 507ELC2
07	91295A001	AY PCB 507E ECG DAUGHTER
08	82510B001	EMI CONNECTOR PLATE
09	42349B001	DRIP SHEILD MAIN BRD

NIBP Assembly

93755A005 AY FNL NIBP MOD KEYED

Item #	CSI Part #	Description
	40283B001	WASHER FLAT #4 NY .062
	40883B001	NUT HEX 4-40 NYLON
	41263B001	LABEL GENERIC SERIAL NO
	42292B001	BAXTER NIBP BOX
	42295B001	BAXTER MODULE FOAM
	91255A005	AY PCB NIBP BAXTER
	93251A002	AY NIBP MTG BASE
	93755T005	NIBP MODULE AY TEST PROC

NIBP Mounting Base

93251A002 AY NIBP MTG BASE

Item #	CSI Part #	Description
01	40067B001	CABLE TIE 4.0"LG NYLON
02	40874B004	P.H.M.S. 4-40X.750 PL PH
03	41669B001	BRKT NIBP MTG
04	41574B001	CABLE TIE .187X7.5LG
05	41575B001	FOAM ADH BACK .188X.75X2
06	41577B001	SWITCH PRESSURE N/C
07	90772A001	AY MOTOR/PUMP NIBP
08	90773A001	AY PRESSURE SWITCH NIBP
09	90774A001	AY 2WAY VALVE NIBP
10	90775A001	AY 3WAY VALVE NIBP
11	91753A002	AY PNEU VALVE-PUMP NIBP
12	91754A002	AY PNEU VALVE\SWITCH NIBP
13	40006B002	SPACER NY #4/.250D/.125L
21	41579B003	CHECK VALVE
22	40296B002	TUBING SILC BLU .125X.250

NIBP VALVE-PUMP ASSEMBLY

91753A002 AY PNEU VALVE-PUMP NIBP

Item #	CSI Part #	Description
02	41571B002	L CONNECTOR, WHT NYLON
03	41700B001	TUBING POLYU .094IDX.187O
04	41700B002	TUBE POLYU .125X.250 85DU

NIBP VALVE/SWITCH ASSEMBLY

91754A002 AY PNEU VALVE\SWITCH NIBP

Item #	CSI Part #	Description
01	40324B008	T CONNECTOR, WHT NYLON
02	41571B002	L CONNECTOR, WHT NYLON
03	41700B001	TUBING POLYU .094IDX.187O
04	41700B002	TUBE POLYU .125X.250 85DU

Printer/Recorder Assembly

95721A001 PRINTER AY 507ELC2

Item #	CSI Part #	Description
01	45152B001	PRINTER HOUSING 507ELC2
02	45151B001	MEMBRANE PAPER FEED
03	91373A001	AY PCB LTP1245 PRNTR I/F
04	84005B002	PRINTER SEIKO W/O KNOB
05	83279B001	PRINTER DOOR 8100/9100
06	42171B002	PRINTER MOUNT
07	42158B001	UPPER SHIELD PRINTER
08	42159B001	LOWER SHIELD PRINTER
09	42187B001	STANDOFF.25 4-40 X .437LG
10	40995B005	P.H.M.S. 4-40X.25 SEMS
11	83111B003	507ELC2 PRINTER CBL
12	83443B001	MOUNTING BRKT PRINTER