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- assembly operations, re-adjustments, modifications or repairs are carried out by persons authorized by Spacelabs Healthcare, and
- the electrical installation of the relevant room complies with the requirements of the standard in force, and
- the equipment is used in accordance with the operations manual.

Spacelabs Healthcare will make available, on request, such circuit diagrams, component part lists, descriptions, calibration instructions or other information which will assist appropriately qualified technical personnel to repair those parts of the equipment which are classified by Spacelabs Healthcare as field repairable.

Spacelabs Healthcare is committed to providing comprehensive customer support beginning with your initial inquiry through purchase, training, and service for the life of your Spacelabs Healthcare equipment.

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Caution:

Rx Only  US Federal law restricts the devices documented herein to sale by, or on the order of, a physician.

⚠️ Before use, carefully read the instructions, including all warnings and cautions.
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Introduction

Overview

Spacelabs Healthcare monitors provide clinical information, when and where you need it, using a complete range of patient monitoring functions. They also are flexible enough to be set for any level of acuity, and they can be precisely and easily adjusted, using touchscreen technology. Some products also provide charting at the bedside and the ability to interact with alarms and information from other devices.

Spacelabs Healthcare networking features support seamless data acquisition and data exchange across the medical enterprise, addressing the need for continuous information management. These powerful tools enhance patient safety and help you care for patients more efficiently by providing access to, and remote control over, patient data.

Following the Introduction chapter, this Operations Manual is organized as follows:

• Chapter 2, Glossary of Terms, provides concise descriptions of features and terms used in this manual.
• Chapters 3 through 5 describe the monitor setup and features.
• Chapters 6 through 8 provide detailed information about admitting and discharging patients, setting up alarm configurations, and printing.
• Chapters 9 through 22 are individual clinical parameter chapters. These chapters contain clinical overviews, diagrams of the touchscreen keys and menus specific to that particular function or parameter, descriptions of the monitor screens, operating instructions, status/error messages, troubleshooting suggestions, and other relevant information.
• Chapters 23 through Appendix A contain information about product and equipment specifications, cleaning and maintenance, diagnostic messages, and symbols related to Spacelabs Healthcare products.

Your system configuration, including the options ordered, may be different from the configurations described in this manual. Refer to the notes in this manual describing the features affected by system configuration.

Warning:

• Visually inspect all patient cables or sensors each time the unit is used. Check for worn or damaged plastic covering, frayed or broken wires, cracked connections, or any other signs of damage. Do not use cables or sensors that exhibit obvious damage.

• If the equipment is dropped, abused, or damaged in any way (if the monitor or module becomes wet, for example), a qualified field service engineer or biomedical engineer must verify that the unit is working correctly and that all safety features are intact.
Introduction

- **Because of the potential for electromagnetic interference, electronic devices (for example, portable communication transmitters, cellular telephones, personal computers, electronic toys, and other medical devices) should not be operated within 3.5 feet (1.07 meters) of the patient, patient leads, or associated monitoring equipment until the devices can be evaluated by the biomedical engineering staff.**

Quickstarts

This manual includes “Quickstarts,” which include steps for explaining how to access and use the various features and parameters of the Spacelabs Healthcare monitors. If specific products require separate steps, the steps are listed in two columns. Refer to *Figure 1-1.*

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<td>- This action applies to SL2200 monitors.</td>
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*Figure 1-1: Quickstart*

SL2200 System Components

**Spacelabs Healthcare monitoring products include:**

- Bedside monitors
- Central monitors
- Parameter modules
- Module housings
- Printers
- Flexport® system interfaces
- Telemetry

*Figure 1-2: SL2200 monitor and Command Module*
Introduction

SL2200 Monitor

The SL2200 is a lightweight, compact monitor with a 10.4-inch touchscreen display. It is designed for bedside and portable use. The SL2200 includes an infrared receiver to support remote keypad operation. The monitor supports one parameter module internally and supports networking. An optional printer and optional wireless networking capabilities are available. The monitor is compatible with the 91493 Integrated Module Housing to support two additional parameter modules.

Parameter Modules

Parameter modules are used with a Spacelabs Healthcare monitor to monitor clinical parameters such as electrocardiography (ECG), noninvasive blood pressure (NIBP), pulse oximetry (SpO₂), Bispectral Index (BIS), and capnography (EtCO₂). Each module is shipped with default settings for alarms and various other operational settings, which can be adjusted to meet the needs of your patients or comply with your hospital’s protocol.

Some parameter modules can also be used to transfer all of a patient’s data from one monitor to another monitor. This is accomplished using the Data Shuttle® option. Refer to Data Shuttle Option on page 3-14 for more information.

Note:

- The SL2200 monitor is limited to three or four waveforms. Some parameters may not display completely.

- When monitoring BIS on an SL2200 monitor with three or four waveforms, BIS should be set to the one-zone display. Refer to the Ultraview SL Operations Manual (P/N 070-1150-xx) for information on using BIS.

- When using a Multigas Analyzer and monitoring gas concentrations on an SL2200 monitor with three or four waveforms, set the GAS parameter to display only one or two zones. Refer to the Ultraview SL Operations Manual (P/N 070-1150-xx) for information on using the Multigas Analyzer.
Installing Parameter Modules

Modules can be inserted directly into the monitor, or into a module housing. Refer to 91493 Integrated Module Housing on page 1-4 for additional information.

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</tr>
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<tbody>
<tr>
<td>• Ensure that the locking lever on the module is closed and that the module is oriented correctly.</td>
</tr>
<tr>
<td>• Insert the module into any open slot in the monitor or module housing.</td>
</tr>
<tr>
<td>• Slide the module into the monitor or module housing until the front of the module is flush with the front of the monitor. A light “click” indicates that the module is locked in place.</td>
</tr>
</tbody>
</table>

If the front of the module is not flush with the front of the monitor or module housing, DO NOT FORCE THE MODULE.

| • Remove the module and clear the obstruction before trying to insert the module again. |
| • If there is no obstruction, check the orientation of the module, then repeat the installation steps. |

<table>
<thead>
<tr>
<th>To remove a module:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Disconnect any cable(s) from the front of the module, if necessary.</td>
</tr>
<tr>
<td>• Push the left side of the locking lever.</td>
</tr>
<tr>
<td>• Hook your finger through the open locking lever, then pull the module out of the slot.</td>
</tr>
</tbody>
</table>

91493 Integrated Module Housing

The 91493 Integrated Module Housing expands the configurability of the SL2200 compact monitor from one to three modules by providing two additional module slots. The Integrated Module Housing directly attaches to the base of the monitor.

Parameter modules can be inserted into or removed from a module housing without disconnecting the power.

The Integrated Module Housing is powered from the monitor, and does not use a separate power supply or cables.

Note:

• Modules inserted into the Integrated Module Housing must be aligned in the correct horizontal orientation.

• The module label text should be readable when the module is inserted properly.
Printers

Patient information in the form of numerical data and waveforms can be printed using the 90449 printer module, the 90469 system printer module or Intesys® Clinical Suite (ICS) Print Manager (91881). An optional integrated printer (option -U) is also available in the SL2200 monitor.

The 90449 printer module is an external printer that prints one- or two-channel waveform recordings on 50-mm heat-sensitive paper. It can store up to three waveforms and annotation values, and is only used as a bedside printer.

The 90469 system printer module is an external printer that prints one-, two-, or four-channel waveform recordings on 50-mm and 120-mm heat-sensitive paper. It can store up to 12 waveforms and annotation values. Four-channel waveform recordings are only available when the four-channel paper tray is used. The 90469 system printer module may be used as a bedside printer or as a central printer.

The SL2200 integrated printer (option -U) is a two-channel printer that provides automatic and manual recordings of parameter data on 50-mm roll paper. The printer prints recordings of parameters in alarm conditions, requested waveforms, and non-waveform data.

ICS Print Manager (91881) enables you to print waveforms and associated annotation values and reports from a monitor to a network printer, instead of using the strip chart printer. Print Manager also retains the print jobs so that you can reprint them at a later time. Print Manager is an integrated component of ICS.

Flexport System Interface

The Flexport system interfaces integrate data from compatible third-party peripheral devices (such as ventilators, multigas analyzers, pulse oximeters, NIBP monitors, intravenous (IV) pumps, incubators, and capnographs) into Spacelabs Healthcare monitors. Refer to External Flexport System Interface Connection on page 3-20 for additional information.

Flexport interfaces provide current numeric data, alarm information, and selected waveforms. All the data communicated to the Spacelabs Healthcare monitor is available at network locations, providing alarms and centralized displays. Contact your Spacelabs Healthcare Sales Representative for additional information.

System Basics

Default Settings

Modules are shipped with factory defaults for alarms and other parameter settings (for example, NIBP reading frequency), which can be adjusted to meet the needs of your patients. When events occur that might cause the selected limits or values to return to the default settings, the monitor may display a CHECK SETUP key in the ECG zone, combined with a low-priority alarm tone (refer to Setting Alarm Limits on page 6-7 for details on alarm priorities). To cancel the message and the alarm, touch the CHECK SETUP key on the display. Refer to Check Setup on page 3-6 for additional information.
Patient Preparation

To prepare a patient for monitoring, attach the lead wires and sensors to the patient and connect the sensor’s cable to the module. Touch a parameter key, then touch menu keys as needed to set up monitoring for a specific parameter. Refer to the parameter chapters for additional information on patient preparation.

**Note:**

*Use only Spacelabs Healthcare parts and accessories with your Spacelabs Healthcare products. Other parts and accessories may degrade performance or damage the components. Refer to the Spacelabs Healthcare Supplies Products Catalog for the part numbers and descriptions of additional parts and accessories.*

Touchscreen Keys

Spacelabs Healthcare monitors use touchscreen keys to execute monitoring functions (refer to Figure 1-3). These keys are:

1. Monitor keys
2. Parameter keys
3. Menu keys

**Note:**

*Throughout this manual, touchscreen keys appear in ALL CAPS.*

The white arrow displayed on-screen indicates the display location that was selected most recently.
Introduction

Monitor Keys

Monitor keys are located in a vertical row along the right side of the monitor’s display. They are always visible and perform specific functions regardless of the parameter being monitored.

HELP — Touch the HELP key and then the touchscreen key if you have questions about a key. A description of that key’s function appears. Touching the HELP key twice displays system information (model and software version) and configuration data.

MONITOR SETUP — Touch this key to remotely enter patient demographic data, modify the display format, adjust brightness, adjust tones, and specify printing settings.

SPECIAL FUNCTIONS — Touch this key to view trends and to view clinical and drug calculations.

TONE RESET/ALARM SUSPEND — Touch this key once during an alarm condition to silence the alarms for 45 seconds at that monitor (bedside or central). Touch the key again during the initial 45-second suspension to silence the alarms for three minutes at the bedside monitor only. Refer to Alarms on page 6-5 for more details.

RECORD — Touch this key to print monitored data using a bedside printer, system printer, or printer module. Touch this key and then touch a flashing parameter key to print parameter data. Refer to Printing on page 8-5.

PREVIOUS MENU — Touch this key to move backward through prior menu levels one at a time. From the Main Menu level, this key removes the menu or window from the display.

NORMAL SCREEN — Touch this key to close any active window and its menus and return the monitor to its basic display.

Parameter Keys

Touching the parameter key to the right of the waveform zone displays menu keys at the bottom of the display that are specific to that parameter.

Menu Keys

The menu keys appear along the bottom of the monitor’s display. They display controls for specific parameters and the monitor keys.

Menu keys that are active appear in a contrasting color. Inactive keys appear dithered or in dim lettering. If you touch an inactive menu key, an error tone sounds.
Introduction

Using a Keyboard and Mouse

Spacelabs Healthcare monitors support standard USB keyboards and mice as optional control devices. An on-screen keyboard is provided for certain applications, such as Admit/Discharge, but you can also use an external keyboard.

If your system is equipped with a mouse, it can be used for selected functions in place of the keyboard or the touchscreen. To use the mouse, position the cursor on a key and click the left mouse button to activate that key.

Remote Control Keypad (90360)

The optional 90360 remote control keypad is a cordless, hand-held transmitter powered by an internal battery. It transmits instructions needed to operate a monitor via infrared signals to the monitor’s receiver. Using the remote control keypad, you can remotely suspend or adjust alarms, access trends, adjust waveform size, and print. The zoom function enlarges menu keys on the monitor, making them easy to read from across the room. The maximum operating range is 6 meters (20 feet) at an angle of up to 45 degrees on either side of the receiver. A single 90360 can be used to control several monitors if each is equipped with an infrared receiver. Refer to Remote Keypad on page 22-1 for additional information.
# Glossary of Terms

This summary provides definitions of terms related to the Ultraview SL™ products.

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-Lead diagnostics</td>
<td>Conventional ECG signatures that accurately represent both the detailed waveforms in each cardiac cycle and their beat-to-beat variability.</td>
</tr>
<tr>
<td>90449 bedside printer module</td>
<td>A two-channel printer that provides automatic and manual recordings of parameter data on 50 mm z-fold paper.</td>
</tr>
<tr>
<td>90469 system printer module</td>
<td>A two- or four-channel printer that provides automatic and manual recordings of parameter data on 50 mm or 120 mm Z-fold paper.</td>
</tr>
<tr>
<td>91517 Capnography module</td>
<td>A mainstream and sidestream gas analyzer designed to measure the concentration of carbon dioxide in a gas mixture. Aids in determining the patient's ventilatory, circulatory, and metabolic status.</td>
</tr>
<tr>
<td>91493 Integrated Module Housing</td>
<td>The 91493 Integrated Module Housing (IMH) expands the configurability of the SL2200 portable monitor from one to three modules by providing two additional module slots. For bedside or transport use, the IMH attaches directly to the base of the portable monitors and does not require a separate power supply or cables.</td>
</tr>
<tr>
<td>Admit/discharge</td>
<td>Enter new patient data, change data for an existing patient, and delete patient data if the patient is discharged.</td>
</tr>
<tr>
<td>Alarm attributes</td>
<td>Alarm attributes (such as tone type and alarm recording) can be independently configured for all parameters via the Module Configuration Manager. For more information, refer to the Ultraview SL Module Configuration Manager System Administration Guide (P/N 070-1245-xx).</td>
</tr>
<tr>
<td>Alarm Limit Review</td>
<td>Provides a snapshot view of bedside alarm limits for all active parameters (only available with specific Ultraview SL modules).</td>
</tr>
<tr>
<td>Alarm recording</td>
<td>A strip recording initiated upon an alarm.</td>
</tr>
<tr>
<td>ALARM SUSPEND key</td>
<td>(Also refer to TONE RESET.) Bedside monitor feature that suspends all alarms and alarm recordings for three minutes.</td>
</tr>
<tr>
<td>Alarm Tone Manager</td>
<td>A feature used by a system administrator to prevent alarm tones from being permanently disabled.</td>
</tr>
<tr>
<td>Arrhythmia</td>
<td>Referring to the monitor's ECG detection and classification capabilities.</td>
</tr>
</tbody>
</table>
# Glossary of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrhythmia trends</td>
<td>Detailed trend presentation of Multiview™ II arrhythmia data.</td>
</tr>
<tr>
<td>Arrhythmia review</td>
<td>The event and class review feature associated with the Multiview II arrhythmia algorithm.</td>
</tr>
<tr>
<td>ART</td>
<td>Arterial Pressure. The first factory-default invasive pressure channel label.</td>
</tr>
<tr>
<td>Battery backup</td>
<td>A feature that preserves patient data during losses of mains power.</td>
</tr>
<tr>
<td>Bispectral Index (BIS)</td>
<td>A mathematical value between 0 and 100 derived from the frequency, power, and phase throughout the entire frequency range of the EEG. [Refer to the Ultraview SL Operations Manual (P/N 070-1150-xx)]</td>
</tr>
<tr>
<td>Calculations</td>
<td>Hemodynamic, respiration, oxygenation, and renal calculations that use input values entered manually, or collected automatically by the system, to produce a set of output values. (page 19-5)</td>
</tr>
<tr>
<td>Capnography</td>
<td>A highly accurate method of measuring respiratory gas values. [Refer to the Ultraview SL Operations Manual (P/N 070-1150-xx)]</td>
</tr>
<tr>
<td>Cardiac output</td>
<td>Evaluates the patient's fluid status and the heart’s pumping ability. (page 13-3)</td>
</tr>
<tr>
<td>Clinical calculations</td>
<td>Refer to the Ultraview SL Operations Manual (P/N 070-1150-xx).</td>
</tr>
<tr>
<td>Clock (system)</td>
<td>A clock can be continually displayed in the lower right corner of the display. (page 3-11)</td>
</tr>
<tr>
<td>Command module</td>
<td>Multiparameter module consisting of eight different parameter configurations of multi-lead ECG, noninvasive blood pressure (adult and neonatal), invasive pressure, pulse oximetry, cardiac output, and temperature combined into a single module. (page 1-3)</td>
</tr>
<tr>
<td>CPP</td>
<td>Cerebral perfusion pressure. An invasive pressure label. (page 14-7)</td>
</tr>
<tr>
<td>Data Shuttle</td>
<td>Transfers up to 24 hours of trend and episodic data, plus patient demographic data (e.g., age, gender, name, and BSA), from one monitor to another. (page 3-14)</td>
</tr>
<tr>
<td>Default settings</td>
<td>Modules are shipped with factory-default settings for alarms and other parameter settings. User-defined settings can be configured using the Module Configuration Manager.</td>
</tr>
<tr>
<td>Density Spectral Array (DSA)</td>
<td>An EEG display format.</td>
</tr>
</tbody>
</table>
## Glossary of Terms

### Diagnostic messages (page 25-1)
A chapter in this manual listing messages that may appear on the display.

### Digital telemetry
Provides continuous monitoring of electrocardiographic signals in order to detect abnormal cardiac rhythms, including asystole, ventricular fibrillation, and ventricular tachycardia.

### Directory of keys
Diagrams of touchscreen keys and menus at the beginning of each chapter.

### Drug Dosage calculations (page 19-19)
Enables you to determine infusion rates for drugs based on drug concentration, desired dose, patient weight, and patient type (adult or neonate).

### Electrocardiograph (ECG) (page 9-5)
A method of continuously monitoring electrocardiographic signals.

### Electroencephalograph (EEG) [Refer to the Ultraview SL Operations Manual (P/N 070-1150-xx)]
A method of acquiring, processing, and displaying two- or four-channel EEG data and one channel of EMG (electromyogram) data.

### Enhanced vital signs
Displays SpO₂, respiration rate, and noninvasive pressure in the ECG zone on central or remote bedside monitors.

### Event (page 16-13)
A change in a patient's condition based on multiple variables.

### Event marks
Indications at the top of any SvO₂ or EEG trend graph to note the point when an event occurs.

### Flexport system interface (page 1-5)
Integrates data from compatible peripheral devices (such as ventilators, multigas analyzers, incubators, and capnographs) into Spacelabs Healthcare monitors.

### Frequency band ratio (FBR)
A measurement of the ratio of total power in two EEG frequency bands.

### Graphic trends (page 20-4)
Refer to Trends (local only).

### HELP key (page 1-7)
Touch the HELP monitor key and then a touchscreen key to display a description of that key's function. Touching the HELP key twice displays a window containing system information (model and software version) and configuration data.

### ICD
Implantable Cardiac Defibrillator.

### ICS
Intesys Clinical Suite.
## Glossary of Terms

**Indication for Use**  
*page 23-1*  
The devices documented herein are indicated for use by health care professionals whenever there is a need for monitoring of the physiological parameters of patients.

The devices documented herein are intended to be used for monitoring of multiple physiological parameters for patients of any age ranging from neonates through adults. In addition to monitoring physiological parameters, these devices also support recording and alarming for those parameters.

**Intended Use**  
*page 23-1*  
The devices documented herein are not therapeutic devices. The devices documented herein are to be used by trained health care professionals in health care facilities. ST segment monitoring is restricted to adult patients only. The devices documented herein are not intended for home use.

**Invasive pressure**  
*page 14-3*  
Uses an intravascular strain-gauge transducer to measure systolic (S), diastolic (D), and mean (M) arterial blood pressures.

**Labels**  
The name that appears on a parameter key, such as a pressure key label (ART, PA, PRS, CVP, etc.).

**Local Calcs**  
*page 19-5*  
Refer to *Calculations* and *Drug Dosage Calculations*.

**Local Trends**  
*page 20-3*  
Refer to *Trends*.

**Masimo SET**  
*page 17-7*  
A pulse oximetry technology developed by Masimo.

**Mainstream and sidestream capnography**  
[Refer to the Ultraview SL Operations Manual (P/N 070-1150-xx)]  
Highly accurate methods of measuring respiratory gas values.

**Module Configuration Manager (MCM)**  
Define and store user-configurable options within your module. For more information, refer to the Ultraview SL Module Configuration Manager System Administration Guide (P/N 070-1245-xx).

**Module housing**  
*page 1-3*  
A lightweight, standalone unit that allows the monitor to support additional parameter modules.

**MONITOR SETUP key**  
*page 1-7*  
Displays a menu for entering patient demographic data, modifying the display format, adjusting tones, and specifying printing settings.

**Montage**  
Used in BIS monitoring to view or enter electrode lead placement, enable EMG, and initiate continuous impedance testing.
Glossary of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Multigas analyzer</strong></td>
<td>Monitors gas concentrations and alerts clinical personnel when the concentration of anesthetic agents, oxygen, carbon dioxide, or nitrous oxide falls outside of defined limits.</td>
</tr>
<tr>
<td>[Refer to the Ultraview SL Operations Manual (P/N 070-1150-xx)]</td>
<td></td>
</tr>
<tr>
<td><strong>Multiparameter telemetry</strong></td>
<td>Digital telemetry product with options to acquire SpO₂ and NIBP data, as well as ECG data.</td>
</tr>
<tr>
<td>[Refer to the Ultraview SL Operations Manual (P/N 070-1150-xx)]</td>
<td></td>
</tr>
<tr>
<td><strong>Multiview I and II</strong></td>
<td>Enhanced (Multiview I) and expanded (Multiview II) arrhythmia detection and alarms. Multiview II also offers storage and review capabilities.</td>
</tr>
<tr>
<td>(page 10-3)</td>
<td></td>
</tr>
<tr>
<td><strong>Noninvasive Blood Pressure (NIBP)</strong></td>
<td>NIBP uses oscillometric monitoring to measure systolic (S), diastolic (D), and mean (M) arterial blood pressures.</td>
</tr>
<tr>
<td>(page 15-1)</td>
<td></td>
</tr>
<tr>
<td><strong>NORMAL SCREEN key</strong></td>
<td>Returns the monitor to its basic display.</td>
</tr>
<tr>
<td>(page 1-6)</td>
<td></td>
</tr>
<tr>
<td><strong>Nurse Alert</strong></td>
<td>An optional external monitor configuration accessory.</td>
</tr>
<tr>
<td><strong>OCR</strong></td>
<td>Refer to oxycardiorespirogram.</td>
</tr>
<tr>
<td><strong>OxiMax</strong></td>
<td>A pulse oximetry technology developed by Nellcor.</td>
</tr>
<tr>
<td>(page 17-14)</td>
<td></td>
</tr>
<tr>
<td><strong>Oxycardiorespirogram</strong></td>
<td>A graph displaying heart rate, SpO₂, and respiratory rates.</td>
</tr>
<tr>
<td>(page 16-5)</td>
<td></td>
</tr>
<tr>
<td><strong>Pacemaker</strong></td>
<td>A cardiac pacemaker.</td>
</tr>
<tr>
<td>(page 9-13)</td>
<td></td>
</tr>
<tr>
<td><strong>Parameter priority and color</strong></td>
<td>Allows control of parameter position and color on the display.</td>
</tr>
<tr>
<td>(page 3-8)</td>
<td></td>
</tr>
<tr>
<td><strong>Patient Data Logger (PDL)</strong></td>
<td>An option that automatically sends patient vital signs from the monitor to an external device, such as a printer or a terminal.</td>
</tr>
<tr>
<td>(page 21-3)</td>
<td></td>
</tr>
<tr>
<td><strong>Patient identification string</strong></td>
<td>A text string used to identify the patient associated with remotely viewed data.</td>
</tr>
<tr>
<td><strong>Physiologic calculations</strong></td>
<td>Refer to Calculations.</td>
</tr>
<tr>
<td><strong>Plethysmograph</strong></td>
<td>Associated with SpO₂.</td>
</tr>
<tr>
<td>(page 17-11)</td>
<td></td>
</tr>
<tr>
<td><strong>Power failure</strong></td>
<td>Loss of mains power. Refer to Battery backup on page 2-2.</td>
</tr>
<tr>
<td><strong>Pressure</strong></td>
<td>Refer to Invasive Pressure.</td>
</tr>
<tr>
<td><strong>PREVIOUS MENU key</strong></td>
<td>Move backwards through prior menu levels one at a time.</td>
</tr>
<tr>
<td>(page 1-7)</td>
<td></td>
</tr>
</tbody>
</table>
### Glossary of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Printer module</strong> (page 8-5)</td>
<td>A module that prints recordings of parameters in alarm conditions, requested waveforms, and non-waveform data.</td>
</tr>
<tr>
<td><strong>Printing priorities</strong> (page 8-7)</td>
<td>Recording requests are printed in a priority order.</td>
</tr>
<tr>
<td><strong>Privileged access</strong> (page 3-13)</td>
<td>Additional features available to any user with an appropriate password.</td>
</tr>
<tr>
<td><strong>Product specifications</strong> (page 23-1)</td>
<td>A chapter in this manual that provides specifications for Spacelabs Healthcare products.</td>
</tr>
<tr>
<td><strong>Pulse oximetry (SpO₂)</strong> (page 17-5)</td>
<td>Allows continuous noninvasive monitoring of a patient's hemoglobin oxygen saturation.</td>
</tr>
<tr>
<td><strong>QRS tone</strong> (page 3-13 and page 9-18)</td>
<td>A tone that occurs each time a QRS complex is detected.</td>
</tr>
<tr>
<td><strong>Quicknet™</strong></td>
<td>Hospitals may choose to install additional network connections in patient rooms or hallways that are not permanently connected to a Spacelabs Healthcare monitor. These additional connections give hospitals greater flexibility in using their floating monitors during periods of high patient census, etc.</td>
</tr>
<tr>
<td><strong>Quickstarts</strong> (page 1-2)</td>
<td>Quickstarts explain how to access and use features of the Spacelabs Healthcare monitors.</td>
</tr>
<tr>
<td><strong>Real-time ST trends</strong> (page 11-13)</td>
<td>An ECG feature that displays 15 or 30 minutes of ST trend data at all times.</td>
</tr>
<tr>
<td><strong>Receivers</strong></td>
<td>Used with a patient-worn telemetry transmitter to provide continuous monitoring of electrocardiographic signals.</td>
</tr>
<tr>
<td><strong>RECORD key</strong> (page 1-7)</td>
<td>Touching this key prints monitored and parameter data using a bedside printer, system printer, or printer module.</td>
</tr>
<tr>
<td><strong>Recording destination</strong> (page 8-14)</td>
<td>Enables you to direct alarm recordings to a bedside printer, a network printer, or both. Other recordings can be directed to a bedside printer or to a network printer, but not to both.</td>
</tr>
<tr>
<td><strong>Remote keypad</strong> (page 22-1)</td>
<td>A cordless, hand-held transmitter that sends instructions, via infrared signals, to the monitor’s receiver. Provides all the functions needed to operate the monitor remotely.</td>
</tr>
<tr>
<td><strong>Remote monitor</strong></td>
<td>Any other monitor on the network.</td>
</tr>
<tr>
<td><strong>Reports</strong> (page 12-3)</td>
<td>12-lead ECG reports.</td>
</tr>
<tr>
<td><strong>Respiration</strong> (page 16-5)</td>
<td>Changes in thoracic impedance during patient inspiration and expiration provided through the ECG cable.</td>
</tr>
</tbody>
</table>
## Glossary of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensorwatch®</td>
<td>A graphical presentation of the amplitude of the signal received from the sensor that can be used to determine the best sensor site and application.</td>
</tr>
<tr>
<td><strong>SL2200 monitor</strong></td>
<td>The SL2200 is a lightweight, compact monitor with a 10.4-inch touchscreen display. It is designed for bedside and portable use. The SL2200 includes an infrared receiver to support remote keypad operation. The monitor supports one parameter module internally and supports networking. An optional printer and optional wireless networking capabilities are available. The monitor is compatible with the 91493 Integrated Module Housing to support two additional parameter modules.</td>
</tr>
<tr>
<td><strong>SL2400 monitor</strong></td>
<td>The SL2400 is a lightweight, compact monitor with a 10.4-inch touchscreen display. It is designed for bedside and portable use. The SL2400 includes an alarm light and an infrared receiver to support remote keypad operation. The monitor supports one parameter module internally and supports conventional networking. An optional printer and optional wireless networking capabilities are available. The monitor is compatible with the 91493 Integrated Module Housing to support two additional parameter modules.</td>
</tr>
<tr>
<td><strong>SL2600 monitor</strong></td>
<td>The SL2600 is a mid-range, compact monitor with a 12.1-inch touchscreen display. It is designed for bedside and portable use. The SL2600 includes an alarm light and an infrared receiver to support remote keypad operation. The monitor supports one parameter module internally and supports conventional networking. An optional printer and optional wireless networking capabilities are available. The monitor is compatible with the 91493 Integrated Module Housing to support two additional parameter modules.</td>
</tr>
<tr>
<td><strong>SL2700/SL2800 monitors</strong></td>
<td>Bedside monitors that use external displays and accommodate two single-high parameter modules.</td>
</tr>
<tr>
<td><strong>SL3800 monitor</strong></td>
<td>A central monitor that displays patient-specific parameters, remote alarms, and alarm limits based on the settings of the bedside monitor, as determined by the primary caregiver.</td>
</tr>
<tr>
<td><strong>SPECIAL FUNCTIONS key</strong></td>
<td>Displays a menu for viewing trends and clinical and drug calculations.</td>
</tr>
<tr>
<td><strong>SpO2 tone</strong></td>
<td>A tone that occurs each time an SpO2 pulse is detected.</td>
</tr>
<tr>
<td><strong>ST analysis</strong></td>
<td>Monitors changes to the ST segment level.</td>
</tr>
<tr>
<td><strong>ST segment review</strong></td>
<td>A review feature associated with the ST segment analysis feature.</td>
</tr>
</tbody>
</table>
### Glossary of Terms

**Standard networking**  
(Refer to the *Ultraview SL Operations Manual* (P/N 070-1150-xx))  
View and interact with parameter data from bedside to bedside monitor, and from bedside to central monitor.

**Status messages**  
Indicate a problem or condition that may affect accurate monitoring values.

**Symbols**  
(page A-1)  
A chapter in this manual that provides graphical illustrations of the symbols used on Spacelabs Healthcare products.

**Tabular trends**  
(page 20-5)  
A table displaying up to 22 rows and 7 columns of continuous or episodic parameter data.

**Telemetry**  
Refer to *Digital Telemetry*.

**Temperature**  
(page 18-3)  
Refer to *Temperature*.

**Titration tables**  
(page 19-25)  
The Drug Dosage calculation feature includes titration tables that appear for each drug record to calculate flow rate and dose.

**TONE RESET key**  
(page 6-9)  
Silences the alarm tone for 45 seconds at that monitor.

**Transmitters**  
(Refer to the *Ultraview SL Operations Manual* (P/N 070-1150-xx))  
Small, battery-powered devices that monitor ECG activity and, optionally, SpO₂/NIBP data, and transmit this information to the digital telemetry receiver module.

**Trends**  
(page 20-3)  
Numeric data collected for a patient over a 24-hour period that is displayed in either a graphical or tabular format.

**Troubleshooting information**  
A section located at the end of most chapters that suggests solutions to common problems.

**Varitrend® 3**  
(page 16-12)  
An optional feature in some ECG modules that generates a graph of heart rate, SpO₂, and respiratory rates (an oxycardiorespirogram).

**VCRR**  
View, control, review, and record data displayed by Spacelabs Healthcare monitors.

**Venous oxygen saturation (SvO₂)**  
A status indicator of the oxygen transport system in critically ill patients.

**Venous stasis**  
(page 15-12)  
Uses the NIBP cuff as the tourniquet for venous cannulation.
## Glossary of Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vitals report</strong></td>
<td>A manual report on 50 mm roll paper of selected parameter data that prints on the SL2200/SL2400/SL2600 compact monitor printer.</td>
</tr>
<tr>
<td><strong>Vital signs trending</strong></td>
<td>Refer to <em>Trends</em>.</td>
</tr>
<tr>
<td><strong>WFI</strong></td>
<td><em>SpO₂</em> waveform index.</td>
</tr>
</tbody>
</table>
Privileged Access

MONITOR SETUP

PRIVILEGED ACCESS
Enter clinical password and touch ENTER

MONITOR SETUP

CLINICAL LEVEL - Select Parameter

TIME/DATE  
PRESELECTED RECORDINGS  
UNITS OF MEASURE  
USER ACCESS  
ALARM SETUP  
MORE

TIME/DATE

USER ACCESS - Enable user access to functions

PATIENT TYPE  
PARAMETER CONFIG  
RECORDING DURATION  
SUBNET ACCESS  
MORE

RECORDING DURATION

Restart monitor after selecting units of measurement

TIME  
DATE  
24 HOURS  
AM PM  
HOURS  
MINUTES  
↑  
↓  
ENTER

MORE

DEFAULT ENG. SAV MODE

ON  
OFF
Privileged Access (continued)

MONITOR SETUP

- PRIVILEGED ACCESS
  - Enter clinical password and touch ENTER

**CLINICAL LEVEL - Select Parameter**

- TIME/DATE
- PRESELECTED RECORDINGS
- UNITS OF MEASURE
- USER ACCESS
- ALARM SETUP
- MORE

**ALARM SETUP - Select Parameter**

- REMOTE ACCESS
- ALARM SUSPEND
- TREND SUSPEND
- ALARM RELAY
- MORE

**ALARM RELAY SETUP - Select Parameter**

- RELAY TIMEOUT
- FLASHING
- ALARM LEVEL

- 0 SEC
- 10 SEC
- STEADY ON

**ALARM LEVEL - Select minimum alarm priority level to trigger relay activation**

- HIGH
- MEDIUM
- LOW
Contents

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Overview

Parameter modules that are inserted into the monitor itself or into a module housing acquire patient data to display as waveforms and numerics.

The SL2200 monitor can (optionally) display up to four parameter zones. If more than four zones are used, numeric keys appear at the bottom of the display for the additional parameters. When you activate a numeric key, that parameter is displayed in the lowest-priority display zone.

Warning:

- Do not use cables or sensors that exhibit obvious damage. Visually inspect all patient cables or sensors each time the unit is used. Check for worn or damaged plastic covering, frayed or broken wires, cracked connections, or any other signs of damage.

- If the equipment is dropped, abused, or damaged in any way (if the monitor or module becomes wet, for example), a qualified field service engineer or biomedical engineer must verify that the unit is working correctly and that all safety features are intact.

- Do not operate electronic devices (for example, portable communication transmitters, cellular telephones, personal computers, electronic toys, and other medical devices) within 1.07 meters (3.5 feet) of the patient, patient leads, or associated monitoring equipment until evaluated by the biomedical engineering staff. Electromagnetic interference may occur when using these devices.

Spacelabs Healthcare monitors and modules have built-in error detection and recovery circuitry that allows the monitor to re-initialize and continue to function if an error occurs. Spacelabs Healthcare monitors also provide battery backup to ensure that patient trends and demographic information is not lost in the event of a short-term power interruption, such as backup generator testing.

When the system detects an error that cannot be corrected through other means, the monitor re-initializes or resets (blanks). Normally, a reset involves very little loss of patient monitoring time (approximately five seconds) and, with few exceptions, all configured user settings (alarm limits, pressure labels, transducer offsets, etc.) are retained. The entire process of restoring the monitor following a reset takes approximately 20 seconds, depending upon the number of parameters being monitored.
Setup and Features

In some cases, stored trend data is lost when the monitor resets. Typically, this is indicative of a hardware condition requiring corrective action. In this case, the system initiates the start-up diagnostics to check the monitor’s operation, so that full recovery takes approximately 10 seconds longer.

Caution:
- Use of the monitor is restricted to one patient at a time.
- Using multiple instances of parameters such as ECG is not supported.

Check Setup

If a bedside monitor resets, a CHECK SETUP key may appear in the ECG zone, and a low priority alarm tone sounds to alert you to check all limits and values and ensure that the monitor has restored all preset values. To cancel the message and the alarm, touch the CHECK SETUP key.

The following events cause the CHECK SETUP key to appear:
- The monitor is powered ON — All parameters reset to their default values or to the values set the last time the monitor was in use.
- An ECG module is inserted — The module values display default settings.
- An error is detected that cannot be corrected through other means — The monitor resets.

Check Setup is an optional feature on the ECG parameter that your system administrator can enable and disable.

Display Detail

Figure 3-1: Ultraview SL2200 monitor
Identifying Special Applications

If your monitor has access to special applications, additional keys identifying those functions appear in the Special Functions menu. Touch the SPECIAL FUNCTIONS key to access these applications.

Special applications include:

• **Patient Data Logger** — Enables you to automatically send patient vital signs from the monitor to an external device, such as a printer or a terminal (refer to *Patient Data Logger* on page 21-3).

Monitor Configuration Features

The Monitor Configuration menu allows you to:

• Adjust display brightness (refer to *Adjusting Display Brightness and Contrast* on page 3-7)
• Set parameter priorities and colors (refer to *Setting Priorities and Colors* on page 3-8)
• Adjust minor graticule lines (refer to *Using Scaled Displays* on page 3-11)
• Access the clock menu (refer to *Using the System Clock* on page 3-11)
• Activate the screen saver (refer to *Activating the Screen Saver* on page 3-12)

Adjusting Display Brightness and Contrast

You can increase or decrease the display brightness on the SL2200 monitors using the Monitor Setup menu.

To adjust display intensity:

- Touch MONITOR SETUP.
- Touch MONITOR CONFIG.
- Touch SCREEN BRIGHTNESS NORMAL/DIM.

SL2200 monitors operating on AC power contain a SCREEN BRIGHTNESS key, enabling you to set the display to NORMAL or DIM. Setting the display to DIM also enables the power saving features, such as shutting off the LEDs and disabling the mouse and keyboard. The display will also dim approximately 30 seconds after the last time a key is touched, or after the final alarm ends.

SL2200 monitors operating on DC (battery) power contain an ENERGY SAVING MODE ON/OFF key that enables and disables the power saving features.
Setting Priorities and Colors

Each parameter displays in the order of its assigned priority. The highest priority appears at the top of the display with the number 1.

The Parameter Config. dialog box enables you to change the priority and color of parameters. Table 1 on page 3-10 lists default priorities and colors for each parameter.

DISPLAY PRIORITIES

The DISPLAY PRIORITIES key lists all the current bed’s supported parameters (ALL), or a selected subset of parameters (CUSTOM). Touching ALL will display all the monitor’s supported parameters.

Touching CUSTOM displays only the subset of parameters the user has selected, such as the parameters used most frequently.

Use the arrows keys to move the parameters between the CUSTOM LIST and the full parameters list. Or, if parameters are already listed under CUSTOM LIST, touch a parameter from the full list, and then touch the desired position under CUSTOM LIST. The new parameter replaces the position of the previous parameter under CUSTOM LIST.

Using the arrow keys to move the parameters from the full list to CUSTOM LIST places the parameter in the lowest position. To change the order of a parameter, touch that parameter, then touch the position you wish to place the parameter.

Note:

- You can configure parameter priorities and positions without the parameter module present.
- Your monitor may not allow changes to parameter priorities or colors. Contact your system administrator for details.

![Figure 3-2: Parameter Config. dialog box (ALL selected)](image-url)
Setup and Features

To change a parameter priority or color:

- Touch MONITOR SETUP.
- Touch MONITOR CONFIG.
- Touch PARAMETER CONFIG.
- Select a parameter.
- Touch the left arrow to move the first parameter into the CUSTOM LIST.
- OR-
- Select the destination priority by touching the position in the CUSTOM LIST column (all subsequent parameters).
- Select a color.
- Select the parameter key to be colored (the key and waveform will appear in the chosen color).
- Touch SAVE to store local color and priority settings.

**INSERT BLANK**

The INSERT BLANK keys enable you to insert a space above or below a parameter. Blanks can be inserted by touching the blank key and then inserting the blank key space into the desired location. After selecting a blank, touch APPLY or SAVE. A blank zone then occupies the corresponding position on the display. All other active parameters move down.

To remove a blank key, touch the blank key then touch the right arrow to move it out of the CUSTOM LIST.

**SAVE**

The SAVE key saves and applies all current settings, including all changes made.

**APPLY**

The APPLY key applies any changes made to the priority and color settings of the current display, but does not save those changes when the monitor is powered OFF. Changes made to a configuration take effect after touching APPLY.

To retain configuration changes after the monitor is powered OFF, you must select SAVE.

**RESTORE**

The RESTORE key discards any changes made to the settings that have not been saved. Touching RESTORE then touching APPLY reverts to the last-saved settings.
FACTORY DEFAULTS

The FACTORY DEFAULTS key resets the factory-default priority and color settings, but does not save them.

Table 1: Parameter Priorities and Colors

<table>
<thead>
<tr>
<th>Parameter Type</th>
<th>Description</th>
<th>Default Priority</th>
<th>Default Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECG1</td>
<td>Electrocardiogram (first lead)</td>
<td>1</td>
<td>Green</td>
</tr>
<tr>
<td>ECG2</td>
<td>Electrocardiogram (second lead)</td>
<td>2</td>
<td>Green</td>
</tr>
<tr>
<td>RESP</td>
<td>Respiration</td>
<td>3</td>
<td>Cyan</td>
</tr>
<tr>
<td>VARI</td>
<td>Varitrend</td>
<td>4</td>
<td>White</td>
</tr>
<tr>
<td>ART</td>
<td>Arterial Pressure</td>
<td>5</td>
<td>Red</td>
</tr>
<tr>
<td>UA</td>
<td>Umbilical Artery Pressure</td>
<td>6</td>
<td>Red</td>
</tr>
<tr>
<td>PA</td>
<td>Pulmonary Arterial Pressure</td>
<td>7</td>
<td>Yellow</td>
</tr>
<tr>
<td>UV</td>
<td>Umbilical Vein Pressure</td>
<td>8</td>
<td>Blue</td>
</tr>
<tr>
<td>CVP</td>
<td>Central Venous Pressure</td>
<td>9</td>
<td>Blue</td>
</tr>
<tr>
<td>RAP</td>
<td>Right Atrial Pressure</td>
<td>10</td>
<td>Blue</td>
</tr>
<tr>
<td>ICP</td>
<td>Intracranial Pressure</td>
<td>11</td>
<td>Magenta</td>
</tr>
<tr>
<td>LAP</td>
<td>Left Atrial Pressure</td>
<td>12</td>
<td>Red</td>
</tr>
<tr>
<td>PRS</td>
<td>Other Pressure (general)</td>
<td>13</td>
<td>Magenta</td>
</tr>
<tr>
<td>UNLP</td>
<td>Unlabeled Pressure</td>
<td>14</td>
<td>Blue</td>
</tr>
<tr>
<td>EtCO₂</td>
<td>End Tidal CO₂ (Capnography)</td>
<td>15</td>
<td>White</td>
</tr>
<tr>
<td>SpO₂</td>
<td>Pulse Oximetry (O₂ saturation)</td>
<td>16</td>
<td>Green</td>
</tr>
<tr>
<td>NIBP</td>
<td>Noninvasive Blood Pressure</td>
<td>17</td>
<td>Red</td>
</tr>
<tr>
<td>SvO₂</td>
<td>Venous O₂ Saturation</td>
<td>18</td>
<td>Magenta</td>
</tr>
<tr>
<td>TCP</td>
<td>Partial Pressure of Transcutaneous O₂</td>
<td>19</td>
<td>White</td>
</tr>
<tr>
<td>BIS®</td>
<td>Bispectral Index</td>
<td>20</td>
<td>Blue</td>
</tr>
<tr>
<td>GAS</td>
<td>Gas Analyzer</td>
<td>21</td>
<td>White</td>
</tr>
<tr>
<td>CO</td>
<td>Cardiac Output</td>
<td>22</td>
<td>Magenta</td>
</tr>
<tr>
<td>TEMP</td>
<td>Temperature</td>
<td>23</td>
<td>White</td>
</tr>
<tr>
<td>INCUB WARMR</td>
<td>Incubator/Warmer</td>
<td>24</td>
<td>White</td>
</tr>
</tbody>
</table>
Setup and Features

Table 1: Parameter Priorities and Colors (continued)

<table>
<thead>
<tr>
<th>Parameter Type</th>
<th>Description</th>
<th>Default Priority</th>
<th>Default Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>PO + ET</td>
<td>SpO₂ and EtCO₂ Flexport System Interface</td>
<td>25</td>
<td>White</td>
</tr>
<tr>
<td>IV</td>
<td>Infusion Flexport System Interface</td>
<td>26</td>
<td>White</td>
</tr>
<tr>
<td>VENT</td>
<td>Ventilator Flexport System Interface</td>
<td>27</td>
<td>White</td>
</tr>
<tr>
<td>OTHER</td>
<td></td>
<td>28</td>
<td>White</td>
</tr>
</tbody>
</table>

**Note:**
When using an older EEG module, the parameter will display as BIS.

**Using Scaled Displays**

Bedside monitors display up to four scaled pressures simultaneously (refer to Pressure on page 14-3). Monitors optionally display minor graticule lines that can be adjusted. Minor graticules are small, dashed line segments that appear between the full-scale graticule lines.

<table>
<thead>
<tr>
<th>Table 1: Parameter Priorities and Colors (continued)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parameter Type</strong></td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>PO + ET</td>
</tr>
<tr>
<td>IV</td>
</tr>
<tr>
<td>VENT</td>
</tr>
<tr>
<td>OTHER</td>
</tr>
</tbody>
</table>

**To adjust the scaled display:**
- Touch MONITOR SETUP.
- Touch MONITOR CONFIG.
- Touch MINOR GRATICULE.
- Select MINOR GRAT / ON.
- Use the arrow keys to adjust.

**Using the System Clock**

A system clock can be continually displayed in the lower right corner of the display.

*Figure 3-3: Clock display formats*
Setup and Features

Activating the Screen Saver

Activating the screen saver displays a blank screen (displaying only the Spacelabs Healthcare logo). The screen is automatically restored by an incoming alarm condition. To disable the screen saver, touch the display, move the mouse, or press any key on the keyboard.

To activate the screen saver:
- Touch MONITOR SETUP.
- Touch MONITOR CONFIG.
- Touch ACTIVATE SCREEN SAVER.

Wireless Networking

The SL2200 monitors have optional features and configurations that support wireless network communication.

Signal Strength Indicator

Monitors that support wireless network communication display a wireless signal strength indicator when communicating over the wireless network. To use wireless communication, the wired network connector must be physically disconnected.

The wireless signal strength indicator is directly below the NORMAL SCREEN key and above the clock. This indicator is left-justified to leave room for monitors to display channel information related to the wireless remote control.

On portable monitors (SL2200), the signal strength indicator displays directly above the battery gauge (refer to Battery Gauge on page 3-18). For adequate signal strengths, the indicator displays as white on a black background. The signal strength indicator changes to yellow when the signal strength is low. In Figure 3-4, adequate signal strength is shown on the left, and low signal strength is shown on the right.

Figure 3-4: Wireless signal strength indicator
Privileged Access Menus

Several additional features are available to any user with a Clinical level of Privileged Access.

Setting the Time and Date

The TIME/DATE key accesses both the time and date menus. The current time or date appears above the menu. Time appears in either a 12- or 24-hour format. Networked monitors display the network time and stand-alone monitors display the internal system time. Time or date changes are not permanent until you touch ENTER on the display.

Setting the time on any networked monitor sets the time for all monitors on that network.

<table>
<thead>
<tr>
<th>To change the system time and date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Touch MONITOR SETUP.</td>
</tr>
<tr>
<td>- Touch PRIVILEGED ACCESS.</td>
</tr>
<tr>
<td>- Enter the Clinical password.</td>
</tr>
<tr>
<td>- Touch TIME/DATE.</td>
</tr>
<tr>
<td>- Select TIME.</td>
</tr>
<tr>
<td>- Select 24 HOURS or AM/PM (12 hours).</td>
</tr>
<tr>
<td>- Select HOURS or MINUTES and use the arrow keys to set time.</td>
</tr>
<tr>
<td>- Touch ENTER.</td>
</tr>
</tbody>
</table>

Setting QRS Tones

Your monitor can be configured to sound a tone whenever an R-wave (QRS tone) or SpO₂ pulse (SpO₂ tone) is detected (this is the default setting) or only when an alarm is occurring. The pitch of the QRS tone can be modulated with the current SpO₂ value.

Your monitor has two options for how the QRS or SpO₂ tone sounds, if it has been enabled via either parameter’s TONE ON/OFF key. Refer to Adjusting Tones on page 9-18 and Adjusting Tone Volume on page 17-18 for more information.

<table>
<thead>
<tr>
<th>To set QRS tones:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Touch MONITOR SETUP.</td>
</tr>
<tr>
<td>- Touch PRIVILEGED ACCESS.</td>
</tr>
<tr>
<td>- Enter the Clinical password.</td>
</tr>
<tr>
<td>- Touch ALARM SETUP.</td>
</tr>
<tr>
<td>- Touch MORE.</td>
</tr>
<tr>
<td>- Select QRS/SPO2 TONE ENABLE / ALWAYS or DURING ALARM.</td>
</tr>
</tbody>
</table>
Data Shuttle Option

The Data Shuttle option enables you to transfer patient demographic data (e.g., age, gender, name, and BSA) and up to 24 hours of trend and episodic data from one monitor to another. This feature transfers data acquired using any Spacelabs Healthcare module or Flexport system interface.

Before you shuttle data from one monitor to another, you must first transfer the data from the source monitor into a Command module. When you remove the module from the source monitor and insert it into the receiving monitor, data can be transferred to the receiving monitor.

Note:
- If the module has been out of the monitor for 10 or more minutes, all data will be lost.
- The time and date set on both the sending and receiving monitors must be identical for the data transfer to be successful.

Transferring Data to the Module

If your monitor and module support the Data Shuttle option, a TRANSFER DATA key displays in the ECG Setup menu. When you wish to transfer data (for example when transporting a monitored patient from one unit to another), touch the TRANSFER DATA key to transfer data into the module. The message TRANSFERRING PATIENT DATA INTO MODULE appears.

Once the data is completely transferred, the monitor sounds a tone and the message DATA TRANSFER COMPLETED appears below the UPDATE TRANSFER and CANCEL TRANSFER keys. The module is now ready to be removed from that monitor. To provide seamless trend information, remove the module and insert it into the receiving monitor within 30 to 45 seconds after you transfer the data. If there is a delay in completing the data shuttle, update the transfer data just before you remove the module.

If you do not transfer the module to the receiving monitor immediately, the source monitor will be storing new data, but the module’s transfer data is not automatically updated. Parameter information acquired between the time you transfer data and the time you remove the module is lost. The monitor indicates this lost information as a gap in the trends of the parameters involved when you retrieve the data.
Setup and Features

After two minutes, a tone will sound once each minute to remind you to update the module with the newly acquired data and the message *DATA TRANSFER COMPLETED, DATA IS XX MINUTES OLD* appears on the monitor. This is the amount of time that has elapsed since you last transferred the data. The monitor updates this message each minute.

If time elapses between data transfer into the module and module removal, you may wish to update the transferred data before you remove the module. To update this data, touch UPDATE TRANSFER. While the data is being updated, the monitor re-displays the message *TRANSFERRING PATIENT DATA INTO MODULE*.

Touch the CANCEL TRANSFER key to clear all data transfer messages and keys from the ECG display zone and purge previously transferred data from the module. The monitor will then reactivate the TRANSFER DATA key in the **ECG Setup** menu.

To transfer data:
- Touch ECG.
- Touch SETUP.
- Select TRANSFER DATA.
- Remove the module after DATA TRANSFER COMPLETED displays.

To update transfer data, touch UPDATE TRANSFER.

To cancel data transfer, touch CANCEL TRANSFER.

Retrieving Transferred Data

When you insert the module into the receiving monitor, the monitor displays the RETRIEVE DATA and CANCEL TRANSFER keys and sounds a low priority alarm tone until you either cancel the data transfer or retrieve the data. The monitor also displays the patient name associated with the data to be transferred and, if applicable, the patient name associated with the data that currently resides in the monitor.

The Admit/Discharge feature does not allow you to purge a prior patient’s data if you insert a module loaded with transfer data. If you attempt to purge patient data in this manner, the following message appears: *Purge is not allowed during transport.*
When you touch the RETRIEVE DATA key, the monitor displays YES and NO keys along with the following message:

YES purges the monitor’s data and retrieves data from the module.

NO cancels this action.

Touch NO to return to the previous screen. Touch YES to transfer the data from the module into the receiving monitor and purge any data previously stored in that monitor.

Once you initiate data retrieval, the monitor removes all data-transfer-related keys from the ECG display zone and displays the message TRANSFERRING PATIENT DATA INTO MONITOR. When the data retrieval into the monitor is complete, the message DATA TRANSFER COMPLETED appears for one minute.

---

**To receive transferred data:**
- Touch RETRIEVE DATA.
- Touch YES.

**To cancel data transfer:**
- Insert the module into the receiving monitor.
- Touch CANCEL TRANSFER.
- Touch YES.
Canceling the Data Transfer After Module Insertion

To cancel a data transfer, touch the CANCEL TRANSFER key.

The monitor displays YES and NO keys along with the following message:

- **YES** purges the data previously transferred into the module.
- **NO** cancels this action.

Touch YES to confirm the cancellation of the data transfer and reactivate the TRANSFER DATA key in the **ECG Setup** menu. Touch NO to return to the previous screen.

Power and Battery Status

The three LEDs on the SL2200 monitor indicate whether the monitor is connected to the AC mains power and the status of any installed batteries. Battery status conditions are indicated as described in the following sections.

**Power LED**

The power LED is located immediately to the right of the ON/OFF button. This LED is lit whenever the monitor is connected to AC mains power via its power supply, and is not lit if the monitor is not connected to the AC mains power.

**Battery LEDs**

**Solid Green LED**

A solid green battery LED indicates that the battery is fully charged. Only a charging cycle or a faulty battery will cause the green LED to flash, and these conditions only occur when a battery is installed in the monitor.
Setup and Features

Flashing Green LED — Battery Charging

A flashing green battery LED indicates an installed battery is being charged and the monitor is not ready for portable use. This LED flashes in a constant pattern with no delays with the monitor powered ON or OFF. The flashing is different than the battery fault detection flash.

*Note:*

*The green LED stops flashing and glows solid when the charging cycle is complete.*

Intermittent Flashing Green LED — Battery Fault Detected

An intermittent flashing green LED indicates that the installed battery will not hold a charge or that it is taking too long to charge. The intermittent signal is a repeating pattern of a solid green LED for one second and a flashing LED for one second. An error message is also added to the error log for review by your system administrator.

To determine whether a battery is faulty, power the monitor ON using the front-panel switch and observe the message that appears along the bottom of the monitor display. Replace a faulty battery with the same battery type.

Unlit LED

A battery LED that is neither solid ON nor flashing indicates that a battery is not present.

Battery Gauge

The battery gauge is always present in the lower right corner of the display when the monitor is operating on batteries (powered ON and not plugged into AC power). This gauge indicates the approximate battery capacity.

*For example, the gauge will display:*

- A fully charged battery
- ¾ battery charge remaining
- ½ battery charge remaining
- ¼ battery charge remaining
- Minimum battery charge remaining

*Note:*

- *Printing drains large amounts of power and can cause the monitor to power OFF without warning.* Therefore, printing is automatically inhibited when the battery power reaches the ½ charge remaining.
- *When the battery power becomes critically low (approximately ¼ charge remaining), the entire battery gauge flashes to emphasize this warning. The monitor may power OFF at any time, depending upon how much power the monitor is using.*
- *Upon power OFF, the monitor will cease to function.*
Monitor Connections

External Power Supply and Network Connections

The connection for the external power supply is shown in Figure 3-8. The green LED to the right of the ON/OFF button on the front panel is ON whenever the unit is powered by an external power supply.

To connect to an external power supply:
- Attach the DC outlet cable to J1.
- Connect the power cord of the external power supply to an AC outlet.

To connect to the 10/100BaseT port for network communication:
- Plug either end of an Ethernet cable into the modular jack connection on the side of the monitor (refer to Figure 3-9 on page 3-20). Network communication is done through the 10BaseT cable assembly only.
- Plug the other end of the cable into the wall in a wall plate with an 8-pin modular jack connector.

Figure 3-8: SL2200 power connection

1 J1 - external power supply connection
Setup and Features

Internal Flexport System Interface Connection

The SL2200 monitor also provides an external Flexport system interface connection (refer to Figure 3-10).

![Figure 3-9: SL2200 10/100BaseT network connection](image)

1. Modular jack connection
2. 10/100BaseT Ethernet cable

External Flexport System Interface Connection

The SL2200 monitor also provides an external Flexport system interface connection (refer to Figure 3-10).
Setup and Features

Figure 3-10: SL2200 monitor power and Flexport connections

1. SDLC terminator
2. Flexport system interface
3. SDLC connection
4. 10/100BaseT Ethernet cable
5. External power supply
## SL2200 Monitor Troubleshooting Guide

<table>
<thead>
<tr>
<th>Clinical Situation</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cannot change parameter priority or colors</td>
<td>Monitor may not be set up to allow the user to change priority or colors.</td>
<td>Contact your system administrator.</td>
</tr>
<tr>
<td>Changed parameter priority or colors are lost</td>
<td>The STORE key was not touched after the selection was made.</td>
<td>Touch the STORE key to make changes permanent.</td>
</tr>
<tr>
<td>SL2200 monitor has no DC power</td>
<td>The monitor was not plugged into an AC outlet while not in use.</td>
<td>Plug the monitor into an AC outlet to recharge batteries.</td>
</tr>
<tr>
<td></td>
<td>No batteries installed.</td>
<td>Install one or two batteries.</td>
</tr>
</tbody>
</table>
Directory of Keys

- **Tones**
  - Refer to Alarms

- **Admit/Discharge**
  - Refer to Admit/Discharge

- **Monitor Config.**
  - Option -D only
  - Refer to Printing

- **Recorder Config.**
  - Refer to Printing

- **Privileged Access**
  - Refer to Setup and Features

---

**Monitor Setup**

- **Energy Saving Mode**
  - ON
  - OFF
  - DC Power
  - Refer to Setup and Features

- **Screen Brightness**
  - NORMAL
  - DIM
  - AC Power
  - Refer to Setup and Features

- **Minor Graticule Config.**
  - Refer to Setup and Features

- **Clock**
  - ON
  - OFF
  - Refer to Setup and Features

- **Activate Screen Saver**
  - Refer to Setup and Features
Perioperative

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Perioperative User Preference Configurations ................. 6

Overview

Perioperative features extend the functionality of Spacelabs Healthcare monitors and modules to the operating
room or critical care setting. Perioperative features on the SL2200 monitor include START CASE/END CASE
keys on the monitor and extended user-configurable display preferences.

Identifying Perioperative Functions

If your monitor was purchased with option -D, Perioperative, additional keys identifying those perioperative
functions appear in the Monitor Setup menu and on the monitor’s menu line keys. Perioperative features
include:

START CASE and END CASE keys — These keys (refer to Figure 4-1) control the operation of the
monitor and modules by case, and silence audible alarms when the alarms are not needed. However,
visual alarm indicators will continue to display upon END CASE, unless ALARM SUSPEND is pressed.

User Preference Configurations — Parameter display configurability is extended by supporting named sets
of configurations for the primary monitor and the secondary monitor display. Up to five separate
configurations can be set for individual users or case types.

Start Case/End Case

When enabled, the monitor displays a key labeled START CASE or END CASE with the menu keys along the
bottom of the monitor's display. The key will toggle to the opposite state when touched and confirmed.

Figure 4-1: START CASE/END CASE menu line key
Starting a Case

Touch START CASE to start a patient case. The **Keep Settings?** dialog box displays. The KEEP SETTINGS key allows you to keep all user-configured parameter module settings.

The DEFAULT SETTINGS key restores the parameter modules to the default settings specified in Module Configuration Manager. For more information, refer to the Ultraview SL Module Configuration Manager System Administration Guide (P/N 070-1245-xx) or contact your hospital system administrator.

![Figure 4-2: Keep Settings dialog box](image)

Touching KEEP SETTINGS or DEFAULT SETTINGS will open a **Purge Patient Data?** confirmation window, if the monitor is configured to query the user (contact your system administrator for details). Touching YES will erase all patient data. Touching NO will retain patient demographic data.

### To start a case:
- Touch START CASE.
- Touch KEEP SETTINGS.
- Touch YES to purge data, or touch NO to keep patient data (if enabled). **-OR-**
- Touch DEFAULT SETTINGS.
- Touch YES to purge data, or touch NO to keep patient data (if enabled).

**Note:**
*If you accidentally press START CASE, you can touch NORMAL SCREEN to prevent the case from starting.*
Ending a Case

You can end a case by touching the END CASE key. The **End case?** confirmation dialog box displays. Touch END CASE in the **End Case?** dialog box to return to the monitoring window. The END CASE button toggles to START CASE.

![End case confirmation dialog](image)

**Figure 4-3: End case confirmation dialog**

When a case is ended, alarm tones are OFF, but alarm monitoring continues, and visual indicators of alarms continue to display. Remote alarm notification is prevented.

**Warning:**

- *Ensure that the case is complete before touching END CASE. Before ending the case, ensure that the patient is being monitored by other equipment or by a dedicated caregiver for a limited time (such as when a patient is being transferred to a transport monitor).*

- *After a case is ended, ALARM SUSPEND should only be used if no patient is connected to the monitor.*

If you touch the ALARM SUSPEND key when the case is ended, visual and audible alarms will not re-initialize. Touch ALARM SUSPEND again or touch START CASE to re-initialize visual alarms. Individual parameters may treat an end case differently. Refer to the appropriate parameter chapter for descriptions of end case functionality, if applicable.

---

**To end a case:**

- Touch END CASE menu button.
- Touch END CASE on the **End Case?** dialog box.
Perioperative User Preference Configurations

The PARAMETER CONFIG. keys, located under the Monitor Setup menu PRIMARY CONFIG. and SECONDARY CONFIG. keys, allow you to set parameter priorities and colors on the primary and secondary monitor display.

Setting Priorities and Colors

Each parameter displays in the order of its assigned priority. The highest priority appears at the top of the display, with the number 1. The Parameter Config. window enables you to change the priority and color of parameters.

Refer to Table 1 on page 3-10 for a list of default priorities and colors for each parameter.

DISPLAY PRIORITIES

The DISPLAY PRIORITIES key lists all the current bed’s supported parameters (ALL), or a selected subset of parameters (CUSTOM). Touching ALL will display all the monitor’s supported parameters.

Touching CUSTOM displays only the subset of parameters the user has selected, such as the parameters used most frequently. You can configure up to five sets, which correspond to tabs 1 through 5 in the Parameter Config. window.

Use the arrows keys to move the parameters between the CUSTOM LIST and the full parameters list. Or, if parameters are already listed under CUSTOM LIST, touch a parameter from the full list, and then touch the desired position under CUSTOM LIST. The new parameter replaces the position of the previous parameter under CUSTOM LIST.
Perioperative

Using the arrows keys to move the parameters from the full list to CUSTOM LIST places the parameter in the lowest position. To change the order of a parameter, touch that parameter, then touch the position you wish to place the parameter.

Note:  
You can configure parameter priorities and positions without the parameter module present.

INSERT BLANK 

The INSERT BLANK keys enable you to insert a space above or below a parameter. Blanks can be inserted by touching the blank key and then inserting the blank key space into the desired location. After selecting a blank, touch APPLY or SAVE. A blank zone then occupies the corresponding position on the display.

To remove a blank key, touch the blank key then touch the right arrow to move it out of the CUSTOM LIST.

SAVE 

The SAVE key saves and applies any changes made to the priority and color settings. CHANGES NOT SAVED displays in the Parameter Config. window until you save the settings. If you touch another tab without saving changes, the previous tabs displays in red.

To retain configuration changes after the monitor is powered OFF, touch SAVE.

APPLY 

The APPLY key applies any changes made to the priority and color settings of the current display, but does not save those changes when the monitor is powered OFF. Changes made to a configuration take effect after touching APPLY.

To retain configuration changes after the monitor is powered OFF, you must select SAVE.

To change the primary monitor parameter priorities or colors:

- Touch MONITOR SETUP.
- Touch PRIMARY CONFIG.
- Touch PARAMETER CONFIG.
- Touch one of the tabs along the top of the Monitor Setup - Parameter Config., if necessary.
- Select a parameter.
- Touch the left arrow to move the first parameter into the CUSTOM LIST.

-OR-
- Select the destination priority by touching the position in the CUSTOM LIST column (all subsequent parameters).
- Select a color.
- Select the parameter key to be colored (the key and waveform will appear in the chosen color).
- Touch SAVE to store the local color and priority settings, or touch APPLY to only display the settings.
RESTORE

The RESTORE key discards any changes made to the settings that have not been saved. Touching RESTORE, then touching APPLY, reverts to the last-saved settings.

FACTORY DEFAULTS

The FACTORY DEFAULTS key resets the factory-default priority and color settings, but does not save them. You can continue to make configuration changes to the display.

RENAME

The RENAME key opens an on-screen keyboard (refer to Figure 4-5 on page 4-8). You can rename the active tab with a name of up to 15 characters.

To rename a Parameter Config. window tab:

- Touch MONITOR SETUP.
- Touch PRIMARY CONFIG. or SECONDARY CONFIG.
- Touch PARAMETER CONFIG.
- Touch a tab (1 through 5).
- Touch RENAME.
- Enter the new name.
- Touch Enter.
Battery Use, Maintenance, and Disposal

Overview

Spacelabs Healthcare products are equipped with a variety of battery types and technologies to meet the demands of powering critical circuits and portable equipment. This section briefly describes the products and types of batteries required for proper operation. Additionally, suggestions are provided for charging practices to optimize battery performance and disposal after the battery no longer functions within the manufacturer’s specifications.

Warning:

* Batteries exposed to short circuit, high temperature, or fire may leak, vent, or explode.*

Caution:

* Follow the manufacturer’s recommended handling procedure. Collect and transport batteries in a manner that prevents short circuit, compacting, mutilation, or any other abuse that would compromise the physical integrity.*

Note:

* Used batteries must be properly disposed of or recycled according to national and/or local regulation.*

* Refer to the product service manual for more details.*

Nickel Metal Hydride Batteries

Nickel metal hydride (NiMH) batteries should be fully charged and discharged at least three times before use to ensure maximum run time. No other maintenance is required for NiMH batteries.

Note:

* Used batteries must be properly disposed of or recycled according to national and/or local regulation.*

Installation

Both sealed lead-acid (SLA) or NiMH batteries can be used in the SL2200 monitor. Refer to *Figure 5-1* to install one or two batteries.
Batteries can be exchanged, without a loss of patient data, under the following conditions:

- The unit is being powered by an external power supply; or
- The unit is operating on batteries (provided one charged battery remains connected at all times during the exchange).

Batteries can also be exchanged when the unit is powered OFF. However, powering OFF the monitor will result in a loss of patient data.

A green battery LED on the front panel flashes when that battery is being charged. The green battery LED is continually illuminated when the charging cycle is complete, if connected to AC power.

**Note:**

- A faulty battery will cause that battery’s green LED to flash intermittently. Replace the faulty battery with the same battery type.
- Only a charging cycle or a faulty battery causes a green battery LED to flash. These conditions only occur when a battery is installed in the monitor.
- The solid green power LED does not indicate the battery charge level.
Alarms

Directory of Keys

Adjusting Alarm Tones

Refer to Introduction

Refer to page 3-7

Refer to Alarms

Refer to Printing

Refer to Introduction

MONITOR SETUP

TONES

MONITOR

CONFIG.

MONITOR SETUP - Select type of tone to change

LOCAL

ALARMS

KEY

TO

NE

ON

OFF

VOLUME ↑

VOLUME ↓

MONITOR SETUP - LOCAL ALARM TONE
Setting up Automatic Alarm Recordings

MONITOR SETUP

RECORDER CONFIGURATION

Recording Duration

Alarm Parameters

Recording Destination

Number of recorder channels

1 2 4

VITALS SETUP

Alarm Recordings to

This Monitor

Network

Both

Other Recordings to

This Monitor

Network

Select parameters that require alarm recordings from BED X

ECG

ON

OFF

RESP

ON

OFF

MORE

Select duration for recordings initiated from this monitor

12 SEC

20 SEC

Only appears if printer is present

*4 channels supported by 90469 only
Reviewing and Printing Alarm Settings (Alarm Limit Review)
Overview

This chapter describes the following:

- Setting alarm limits
- Setting alarm tones
- Silencing and suspending alarms
- Specifying parameters for automatic alarm recordings

Note:

The bedside monitor is the primary monitoring and alarming device for Spacelabs-monitored parameters.

When a parameter value on a bedside monitor exceeds an alarm limit, that monitor initiates an alarm. User notification of an alarm has four possible characteristics: visual, audible (tone), recorded, and alarm relay. The alarm’s severity defines which of these characteristics is used for that particular alarm.


Warning:

- Alarm conditions for which you want to be alerted must be set to ON or enabled at the location where you want to be alerted — either bedside or central. You can enable them from the local bedside monitor, remote bedside monitor, or central monitor.
- To protect the patient's safety, do not silence, suspend, or disable audible alarms without providing continuous, direct observation of the patient.
- Default alarm settings are not appropriate for all patients. Set high and low alarm limits for the age and condition of the patient being monitored.
- Monitor reverts to default alarm settings when the monitor is not connected to the AC mains supply and the battery charge is exhausted.
Caution:
Verify alarm settings on the monitor once during each shift and upon each patient admission to ensure that the alarm settings are appropriate for the patient being monitored.

Note:
• Within 1 second, the network is notified of an alarm condition.
• Central station alarms will be displayed within 1 second of a bedside alarm condition.

A majority of physiological alarms default to high- and medium-priority alarms, and most technical alarms default to low-priority alarms. For patient safety, a few technical alarms (such as ECG’s LEADS OFF alarm) default to medium-priority alarms. The Module Configuration Manager enables you to adjust these alarms. Refer to the Ultraview SL Module Configuration Manager System Administration Guide (P/N 070-1245-xx).

Two factors affect how physiological parameters initiate and terminate alarms:
• how each physiological parameter is displayed, and
• how each physiological parameter initializes alarms.

How Physiological Parameters are Displayed
Some parameters automatically appear and disappear from the monitor display, depending on whether their sensors are connected or disconnected. These parameters include SpO₂, Temperature, Invasive Pressure, and Cardiac Output.

Other parameters, such as ECG and NIBP, are continuously displayed regardless of connection status.

How Physiological Parameters Initialize Alarms
Alarm processing for continually acquired parameters (e.g., ECG, SpO₂, Invasive Pressure) normally begins after that parameter detects a valid patient connection. It then initiates data analysis. Refer to Learning and Relearning on page 10-6 for more information.

Alarm processing for episodically acquired parameters (e.g., NIBP) begins after the first successful reading. Technical alarms for all parameters normally end when parameter alarms are set to OFF. Physiological and technical alarms for parameters such as SpO₂, Temperature, and Invasive Pressure also end automatically when those parameters disappear from the monitor display (because their sensor is no longer connected).
Default Alarm Limits

Default alarm limit settings are activated under any of the conditions listed below. You can modify these settings to meet your own protocols.

- The monitor is powered ON.
- A module is inserted.
- A parameter is enabled.

Caution:
Verify alarm limits settings are appropriate for the patient being monitored, if the default alarm limits settings are selected.

Note:
To define your own default parameter settings and alarm settings, refer to the Ultraview SL Module Configuration Manager System Administration Guide (P/N 070-1245-xx).

Setting Alarm Limits

A parameter’s Alarm Limits menu allows you to enable and change alarm limits for that parameter. The following Quickstart lists the basic procedure used to adjust high or low alarm limits for a parameter. For details concerning setting or adjusting alarm limits for a specific parameter, refer to the Alarms section of the appropriate parameter chapter in this manual.

To set alarm limits:

- Touch a parameter key (ECG, TEMP, etc.).
- Touch ALARM LIMITS.
- Ensure ALARMS are set to ON.
- Select HI = or LO =.
- Use the arrow keys to adjust.
Identifying Alarm Levels

Alarm conditions are visually and audibly prioritized as high, medium, or low.

Note:
Alarm priorities are set using the Module Configuration Manager. Refer to the Module Configuration Manager System Administration Guide (P/N 070-1245-xx) for more information.

<table>
<thead>
<tr>
<th>Priority</th>
<th>Tone Type*</th>
<th>Tone Duration</th>
<th>Visual</th>
<th>Flash Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Two bursts of five tones every 15 seconds, or continuous tone.</td>
<td>Until the alarm condition is resolved, the alarm is suspended, or the tone is reset.</td>
<td>Flashing key; message appears in red.</td>
<td>500 ms ON / OFF</td>
</tr>
<tr>
<td>Medium</td>
<td>Burst of three tones every 30 seconds, or intermittent tone (one second ON, one second OFF).</td>
<td>Until the alarm condition is resolved, the alarm is suspended, or the tone is reset.</td>
<td>Flashing key; message appears in yellow.</td>
<td>500 ms ON / OFF</td>
</tr>
<tr>
<td>Low</td>
<td>One tone every 30 seconds, or intermittent tone (one second ON, four seconds OFF).</td>
<td>Until the alarm condition is resolved, the alarm is suspended, or the tone is reset.</td>
<td>Flashing key; message appears in yellow.</td>
<td>500 ms ON / OFF</td>
</tr>
</tbody>
</table>

* The repetition rate for the High, Medium, and Low alarm tones can be adjusted by your system administrator.

Warning:
Parameters shown in the ECG display zone in ENHANCED VITAL SIGNS mode do not generate an alarm at the central monitor.

Adjusting Alarm Tones and Key Tones

Alarm tones refer to the sound associated with an alarm condition. Key tones sound each time you touch a display key.

You can turn the alarm tone ON or OFF and adjust the tone volume for local alarms. While you are adjusting tone volume, a tone sounds briefly as an example of the new volume level.
Alarms

Warning:

• **Disabling alarm tones at a monitor eliminates alarm tones for all alarm conditions at that monitor, even in the case of life-threatening events.**

• **Check alarm volumes periodically! Turning the volume off or too low may defeat the audible alarm function.**

Volume adjustments affect only the monitor where the adjustment is made. The volume of an alarm tone at a remote monitor must be adjusted at that monitor and cannot be adjusted remotely. A visual alarm notification is displayed until the condition is resolved, even if you disable the alarm tones at that monitor.

### Silencing Alarm Tones and Alarm Suspend

The Alarm Suspend feature is only available at bedside monitors. If this feature has been disabled (set to OFF), the Alarm Suspend feature is not available.

To set local alarm tones or key tones:

- Touch MONITOR SETUP.
- Touch TONES.
- Select LOCAL ALARMS or KEY TONE.
- Select TONE / ON.
- Use the VOLUME↑ and VOLUME↓ keys to adjust.

To silence an alarm tone for 45 seconds at any monitor, touch TONE RESET once.

To suspend all alarms at a bedside monitor for three minutes, touch the ALARM SUSPEND key again within 45 seconds.

**Note:** If alarms resume the second time the key is touched, your bedside monitor may be configured differently for this feature. Contact your system administrator for details.
Alarms

During an Alarm Condition

If you touch TONE RESET once at a monitor during an alarm condition:

- The alarm tone is silenced at that monitor for 45 seconds. If the alarm condition continues, the alarm tone resumes at that monitor at the end of the 45-second period. If another parameter goes into alarm during this period, or if the initial condition ends and then begins again, the alarm tone will again sound at that monitor.

Note:

- The single alarm tone may sound at other bedside monitors if a second or new alarm condition is recognized during the 45-second period.
- TONE RESET is applicable only to local bedside monitors; audio alarms continue at the central monitor.
- The message ALARM TONES SILENCED FOR 45 SECONDS appears only on that monitor.
- All flashing parameter keys continue to flash.
- The TONE RESET key changes to ALARM SUSPEND.

At a bedside monitor, when you touch ALARM SUSPEND within the 45-second period:

- All alarms and alarm recordings are suspended for three minutes. No alarms sound for any reason during this period, and no new alarm recordings are produced.
- A message appears to indicate that all alarms are suspended.
- Trend data may not be collected. This feature can be enabled or disabled only by your system administrator.
- The ALARM SUSPEND key changes to RESUME ALARMS after the first key touch.

In the Absence of an Alarm Condition

Touching the ALARM SUSPEND key once when no parameters are in an alarm condition suspends the alarms at the bedside monitor for three minutes. (Refer to During an Alarm Condition on page 6-10.)

Note:

- You cannot suspend alarms from a central monitor. However, you can silence alarm tones for 45 seconds. Touching this key has no effect if it is touched at the central monitor when no alarm is sounding.
Alarms

Alarm Tone Manager

A system administrator with a Biomed level of Privileged Access can enable the Alarm Tone Manager to prohibit an individual alarm tone from being permanently disabled.

A minimum volume can be set for alarm tones to ensure they are at a safe and audible level.

When the Alarm Tone Manager is disabled (this is the default setting), access to the TONES keys in the Monitor Setup menu is inhibited.

Automatic Recording of an Alarm

Spacelabs Healthcare strongly recommends verifying alarm parameter settings on the monitor once during each shift and upon each patient admission.

An alarm recording prints the last 12 or 20 seconds (based on RECORDING DURATION setting), or until the alarm ceases or is suspended, whichever is greater. Recordings can be terminated at the printer by touching its STOP (or RESET) key, by taking the printer offline, or by turning the printer OFF. Printing on a network printer is configuration-dependent. Contact your system administrator for details.

The ALARM PARAMS key displays a menu of parameters that can initiate alarm recordings. If alarm recordings are disabled for a parameter, no alarm recording is produced on either the bedside or the network printer if that parameter goes into an alarm condition. However, the designated alarm tones are still generated and the alarm messages are displayed. Use the key labeled OTHER ON/OFF for any new parameter not yet on the Alarm Parameters menu.

When a printer is present in the monitor and is selected and online, an alarm recording is automatically directed to that printer. If a printer is not attached to the monitor, the recorder channel keys do not appear in the menu.

To select parameters for alarm recording and generate automatic recordings on a bedside printer:

- Touch MONITOR SETUP.
- Touch RECORDER CONFIG.
- Select RECORDING DESTINATION.
- Select a destination for the alarm recording.
- Touch PREVIOUS MENU.
- Touch ALARM PARAMS.
- Select parameter key(s) ON to initiate a recording in case of alarm. If the parameter key is OFF, no alarm recording is produced for that parameter in an alarm condition.
Alarm Limit Review

Touch the ALARM LIMIT REVIEW key on a bedside or central monitor to view alarm settings and the alarm volume for a selected monitor at that point in time. Touch the PRINT key at the bottom of the Alarm Limit Review dialog box to print the alarm settings.

To view the Alarm Review dialog box:

- Touch SPECIAL FUNCTIONS.
- Touch ALARM LIMIT REVIEW.
- Use the scroll bar if necessary.
- To print the Alarm Limit Review, touch PRINT

The alarm settings for modules and Flexport interfaces that do not support this feature are displayed as NOT SUPPORTED.

Figure 6-1: Alarm Limit Review
## Alarms

### Alarms Troubleshooting Guide

<table>
<thead>
<tr>
<th>Clinical Situation</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duplicate alarm recordings print at the bedside and system printer</td>
<td>- Alarm recordings are directed to both bedside and network printers with the RECORDING DESTINATION key.</td>
<td>- Select THIS MONITOR or NETWORK for alarm recordings.</td>
</tr>
<tr>
<td>No alarm recordings are printed</td>
<td>- Parameters for alarm recordings are set to OFF.</td>
<td>- Select parameters for alarm recordings from the <strong>Alarm Parameters</strong> menu.</td>
</tr>
<tr>
<td></td>
<td>- Bedside printer is OFF.</td>
<td>- Turn bedside printer ON.</td>
</tr>
<tr>
<td></td>
<td>- The alarms have not been directed to the bedside printer.</td>
<td>- Ensure that THIS MONITOR or BOTH is selected.</td>
</tr>
<tr>
<td></td>
<td>- Alarms are suspended for three minutes.</td>
<td>- Ensure that alarms are not suspended.</td>
</tr>
<tr>
<td></td>
<td>- System printer is not identified as one of two network printers.</td>
<td>- Have your system administrator verify configuration.</td>
</tr>
<tr>
<td></td>
<td>- Printer is out of paper.</td>
<td>- Load paper into printer.</td>
</tr>
<tr>
<td>Alarms continue to violate after touching ALARM SUSPEND</td>
<td>- More than one alarm may be in violation.</td>
<td>- Touch ALARM SUSPEND again.</td>
</tr>
<tr>
<td>No alarm notification occurs at a central monitor</td>
<td>- Parameters not displayed.</td>
<td>- Display the desired parameters using SCREEN FORMAT under MONITOR SETUP.</td>
</tr>
</tbody>
</table>
Admit/Discharge

Directory of Keys

Admitting a Patient

Refer to Introduction

Refer to Alarms

Refer to Printing

Refer to Introduction

Refer to page 7-2

Patient Demographics - Bed ICU3

Patient Name: Doe, John J
ID 1: 560016
ID 2: 483255
Date of Birth: 6-JUN-1984
Age (years): 50
Height (cm): 150.0
Weight (kg): 125.000
BSA (m²): 2.11
Gender: MALE
Patient Type: ADULT
Location: Room 2

ADMIT / DISCHARGE - Select function

ADMIT

CHANGE DATA

DISCHARGE

Refer to page 7-2

Refer to page 7-2

Page 1

Monitor Setup - Change Patient Data for Bed ICU3

Page 2

Monitor Setup - Change Patient Data for Bed ICU3
Discharging a Patient

Patient Demographics – Bed 103

Patient Name: Doe, John J
ID 1: 599010
ID 2: 454922
Date of Birth: 6 JUN 1994
Age (years): 50
Height (cm): 160.0
Weight (kg): 125.000
BSA (m²): 2.11
Gender: MALE
Patient Type: ADULT
Location: Room 2

DISCHARGE – Are you sure? (All data for the bed will be purged)

YES  NO
Admit/Discharge

Overview

This chapter describes how to enter new patient data, change data for an existing patient, and delete patient data if the patient is discharged. You can access the Admit/Discharge menu either from the central monitor or from a bedside monitor. However, if you are accessing this menu at a central monitor, you must also select the patient's bed (this is not necessary at a bedside monitor).

The only information required when admitting a patient to the system is the patient's name (up to 40 characters per field). Entering the patient's ID number (up to 15 characters) or other demographic data is optional.

Changing or Entering New Patient Data

Touch the ADMIT/DISCHARGE key on the Monitor Setup menu to display the Patient Demographics dialog box (refer to Figure 7-1).

![Patient Demographics dialog box](image)

*Figure 7-1: Patient Demographics dialog box*
To admit a new patient, touch the ADMIT key on the Patient Demographics dialog box. YES and NO keys appear at the bottom, along with a prompt to purge the existing data (refer to Figure 7-2).

To admit a new patient:
- Touch ADMIT.
- Select YES to purge the existing data for that bed.
- Select a field and enter information using the on-screen keyboard (or the drop-down lists for Gender and Patient). (Touch ENTER to move to the next field.)
- Touch the Page 2 tab to access additional patient data fields.
- Touch SAVE to store the new patient data.

To change existing patient data:
- Touch CHANGE DATA.
- Follow the last three steps under “To admit a new patient” above.

To discharge a patient:
- Touch DISCHARGE.
- Touch YES to purge the existing data.

To access the Patient Demographics dialog box:
- Touch MONITOR SETUP.
- Touch ADMIT/DISCHARGE.

Figure 7-2: Purge existing data

To admit a new patient, touch the ADMIT key on the Patient Demographics dialog box. YES and NO keys appear at the bottom, along with a prompt to purge the existing data (refer to Figure 7-2).

Touch YES to open the Admit Patient Data dialog box. The fields are blank for you to enter new patient information.

To change existing patient information, touch the CHANGE DATA key on the Patient Demographics dialog box. This key is disabled if there is no patient name or no ID number stored in the system. The information displayed in the Change Patient Data dialog box matches the information that was displayed in the Patient Demographics dialog box.

Caution:
- Only use CHANGE DATA to update information on an existing patient.
- Never use CHANGE DATA to enter information for a new patient. Discharge the existing patient, which purges the data from the monitor, before entering data for a new patient.
Admit/Discharge

You can use the on-screen keyboard to enter or change patient information. You can also use an external computer keyboard to enter patient data into the selected field. Touching the **Page 2** tab accesses additional patient data fields (refer to *Figure 7-4*).

Selecting the **Gender** field lists three choices — blank, MALE, and FEMALE.

The **Type** field displays ADULT by default. Change this field to NEONATE, if appropriate. On central monitors, the **Type** field is unavailable if the remote monitor where the admission occurs does not support the Type selection.

![Figure 7-3: Entering patient information — Page 1](image)

- **Del** — Deletes the character to the left of the cursor.
- **←** Moves the cursor left one position.
- **→** Moves the cursor right one position.
- **Restart** — Re-displays the last name or value stored and deletes all earlier changes.
- **Clear** — Deletes the currently displayed name or value.
- **Enter** — Moves to the next field.
- **Caps Lock** — Locks the keyboard in ALL CAPS mode.
- **Shift** — Toggles the SHIFT mode ON and OFF.
- **Ins** — Toggles the INSERT mode ON and OFF.
- **Spacebar** — Inserts a space.
- **SAVE** — Enters the data into the system and completes the Admit procedure.
- **Tab** — Moves to the next input field.
- **Ctrl** — Causes the next key to be treated as a control character.
- **Alt** — Causes the next key to be treated as an alternate control character.
- **Alt Gr** — Causes the next key to be treated as an alternate graphics character.
Entering Height, Weight, and Body Surface Area (BSA)

You can adjust the values for height, weight, and BSA up or down within the valid range (refer to Table 1). The values last set for height, weight, and BSA remain until they are manually changed.

Height and weight can be displayed in either U.S. or metric units (contact your system administrator for details). The system automatically computes BSA from the values entered for height and weight, and uses this BSA value to obtain indexed values for physiologic calculations, such as cardiac output.

<table>
<thead>
<tr>
<th>Field</th>
<th>Units</th>
<th>Valid Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>cm</td>
<td>20 to 215</td>
</tr>
<tr>
<td></td>
<td>in</td>
<td>7.9 to 84.6</td>
</tr>
<tr>
<td>Weight</td>
<td>kg</td>
<td>0.2 to 250</td>
</tr>
<tr>
<td></td>
<td>lb</td>
<td>0.44 to 551.16</td>
</tr>
<tr>
<td>BSA</td>
<td>m²</td>
<td>0.03 to 3.69</td>
</tr>
</tbody>
</table>

BSA = Ht $^{0.725} \times$ Wt $^{0.425} \times$ 0.007184
Discharging a Patient

To clear the bedside monitor of existing patient data, touch the DISCHARGE key. Touch YES to purge the existing patient data to complete the discharge.

Scanning Barcoded Demographic Data

*Note:* Only bedside monitors support scanning of barcoded demographic data.

Scanning a valid demographic data barcode reduces the patient admission process time by automatically replacing the currently displayed demographic data with the scanned data.

The Barcode Verification dialog box includes a Scanned column containing the newly scanned data, and a Current column containing the data currently stored in that monitor. The information in the Scanned column updates as additional data is scanned.

The scanning process differs as follows, depending on the data being scanned:

- If the scanned data includes the same Patient Name and ID 1 number as the current data, follow the instructions under Scanned Data with Same Name and ID 1 Number below.
- If the scanned data includes a different Patient Name or ID 1 number than the current data, follow the instructions under Scanned Data with Different Name and ID 1 Number on page 7-9.
Scanned Data with Same Name and ID 1 Number

1. Scanning a barcode displays the following **Barcode Verification** dialog box. The SAVE and CANCEL keys allow you to store the barcode input or cancel it (refer to Figure 7-5).

![Barcode Verification dialog box](image1)

Figure 7-5: Barcode Verification dialog box with SAVE/CANCEL keys

2. Touching SAVE or CANCEL displays the **Patient Demographics** dialog box with keys labeled ADMIT, CHANGE DATA, and DISCHARGE along the bottom.
   - If you touch CANCEL, the information from the Current column appears (refer to Figure 7-6).
   - If you touch SAVE, the information from the Scanned column appears (refer to Figure 7-7).

![Patient Demographics -Scanned](image2)

![Patient Demographics -Current](image3)

Figure 7-6: Scan cancelled

Figure 7-7: Scan saved

3. Complete the admission as described in **Changing or Entering New Patient Data** on page 7-3.
Scanned Data with Different Name and ID 1 Number

1. Scanning a barcode displays the following **Barcode Verification** dialog box. You are then requested to verify the purge of existing (current) data (refer to *Figure 7-8*).

![Barcode Verification for bed ICU]

**Figure 7-8: Barcode Verification with purge confirmation keys**

2. Touching YES or NO displays SAVE and CANCEL keys at the bottom of the dialog box.
   - If you touch NO, the existing data is not purged and the **Current** column remains the same (refer to *Figure 7-9*).
   - If you touch YES, the existing data is purged and all information in the **Current** column (except Patient Type) is cleared (refer to *Figure 7-10*).

![Barcode Verification for bed ICU]

**Figure 7-9: Data not purged**

![Barcode Verification for bed ICU]

**Figure 7-10: Data purged**
3. Touching SAVE or CANCEL displays the **Patient Demographics** dialog box (refer to Figure 7-11 and Figure 7-12).

   - If you touch CANCEL, then the information matches the **Current** column in Figure 7-9.
   - If you touch SAVE, then the information in the **Scanned** column in Figure 7-10 is stored and displayed.

![Figure 7-11: CANCEL selected](image1)

![Figure 7-12: SAVE selected](image2)

4. Complete the admission as described in **Changing or Entering New Patient Data** on page 7-3.
Admit/Discharge Troubleshooting Guide

<table>
<thead>
<tr>
<th>Clinical Situation</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient name incorrect as entered on keyboard menu</td>
<td>Name exceeds 40 character maximum and system has written over some characters.</td>
<td>Re-enter name using 40 characters or fewer.</td>
</tr>
<tr>
<td></td>
<td>No patient name or ID number stored in system.</td>
<td>Enter name or ID number.</td>
</tr>
</tbody>
</table>
Printing

Directory of Keys

Setting up the Printer

MONITOR SETUP

REFER TO INTRODUCTION

REFER TO INTRODUCTIONS

REFER TO RECORDS

REFER TO INTRODUCTIONS

RECORD CONFIGURATION

RECORDING DURATION

ALARM PARAMS

RECORDING DESTINATION

Number of Recorder Channels

1 2 4

VITALS SETUP

*4 channels supported by 90469 only

Configure parameters or start vitals recording

Alarm Recordings to:

THIS MONITOR

NETWORK

BOTH

Other Recordings to:

THIS MONITOR

NETWORK

Select parameters which require alarm recording from bed x

ECG

RESP

ON OFF

ON OFF

... MORE

Select duration of recordings initiated from this monitor

12 SEC 20 SEC
Obtaining Recordings from the Monitor

- Touch RECORD once
- Touch RECORD twice

RECORDER MENU

- CONTINUOUS RECORD
- RECORD ALL
- RECORD PRESELECTED A
- RECORD PRESELECTED B
- PRINT VITAL SIGNS

Touch this key, then touch the desired parameter key (up to four), for each parameter to be continuously recorded.

Controlling Recordings from the Monitor

SYSTEM PRINTER MODULE

- PRINTER (1 - 8)

PRINTER CONTROL MENU

- STOP RECORDING
- CONVERT TO CONTINUOUS
- SLOW ON OFF
- PRINTER ON OFF

SL2200 Printer

- PRINTER CONTROLS
Defining Preselected Recordings

MONITOR SETUP

PRIVILEGED ACCESS

Enter Clinical password

PRESELECTED RECORDINGS

PRESELECTED RECORDINGS - Select configuration to change

PRESELECTED A  PRESELECTED B

Select option to change - X: (current selection displays)

SELECT TYPE  SELECT BED

Select beds/subnets - X: (current selection displays)

ALL SUBNETS  THIS SUBNET  THIS MONITOR

Select recording type - X: Beds = (current selection displays)

ALL BEDSIDE BEDSIDE PARAM(S)  ↑  ↓  CONFIGURED PARAMETERS
Overview

This chapter describes the following Spacelabs Healthcare printers:

- SL2200 printer (optional)
- 90449 bedside printer module
- 90469 (two- and four-channel) system printer module
- 91881 ICS Print Manager

Printers can provide printouts of the following:

- Automatic recordings of any parameter in an alarm condition (if configured in the Module Configuration Manager and if the Alarm Parameters function is enabled for that parameter).

- Parameter data such as:
  - patient name, bed name, and time and date of the printout
  - vital signs, edge annotation, and scaling information
  - waveform data (including timing tick marks and a grid)
  - arrhythmia/ST segments

- Non-waveform data displayed on-screen, such as:
  - tabular trends
  - hemodynamic calculations
  - drug dose calculations
Printing Configurations

Each Spacelabs Healthcare, network-connected, patient monitor is capable of sending recordings to either of two network printers. These can be configured in several ways.

**Configuration #1**

The two printers share the printing load, and the monitor automatically determines which printer is best for each type of recording:

- Generate the most timely output of high priority recordings.
- Ensure that subsequent recordings from one patient over a short time span are processed by one printer.
- Use paper as efficiently as possible.

When the printing load is heavy, these objectives may conflict.

**The following factors are taken into consideration when a print request occurs:**

- Are either of the two printers outputting, holding in memory queue, or loading in queue a print job from this monitor?
- Are either of the printers idle?
- Is this a high priority request (alarm vs. manual)?
- Are either of the printers currently printing a continuous recording?
- Are either of the printer’s queues full?
- Which of the printers is the preferred size for this request (1, 2, or 4 channels) ?

At the time of a printing request, the monitor from which the request originated evaluates both of the available printers one at a time, providing a score for each of the two printers. Each printer’s evaluation passes all the way through the priority tree from the score at the top of the tree to the score at the bottom of the tree. The printer generating the highest score gets the job. If the evaluation produces the same score for each printer, the print job is sent to the printer designated as the primary printer for that monitor.

**Configuration #2**

One printer is designated as the primary and the other printer is designated as the backup.

**All recordings are sent to the primary printer, unless it is unable to print for one or more of the following reasons:**

- Off-line
- Out of paper
- Disconnected from network
- Powered OFF
- Print queues are full
Printing

- Unable to accept recording type

If the primary printer is unable to print, the recordings are then sent to the backup printer, unless it is also unable to print for a reason listed above.

Configuration #3

Only one printer is available because the network is configured so that recordings from a given monitor are directed to only one printer on the network. During times of simultaneous multiple bed alarms, the selection rules will not be applicable, and print performance will be affected.

Printing Priorities

The following list defines printing priorities from the highest to lowest:

- Alarm recording or a manual recording request via a monitor
- RECORD ALL request via a bedside monitor
- Non-waveform recordings (for example, trends)
- All Arrhythmia/ST classes

In all network printing cases:

- High priority print jobs bump lower priority jobs. For instance, an alarm recording will bump graphic trends to a lower position in the print queue.
- A high priority request erases as many lower priority requests as needed to make room for the data it contains. For example, a fully loaded printer will bump graphic trends out of the queue.

A status message is not displayed when a print request replacement occurs.

Note:

Recordings in the process of being printed cannot be interrupted or delayed by additional print requests.

Recording Buffer and Printer Transitions

The printer modules have limited ability to store the waveform data for additional printouts while actively printing.

A continuous manual printout or an alarm printout may exceed the capacity of the printer module’s storage buffer. When the current printout ends and the next queued printout begins, the printer will output the stored waveform data, followed by current waveform data. A printer transition indicator displays between the end of the stored waveform data and the beginning of the current waveform to mark a section of missing waveform data. The width of the indicator is constant. It does not indicate the amount of missing data, just that there is data missing.

The printer transition indicator is indicated on the printer strip by a downward line, followed by a bottom flatline, then a rapid return to the waveform (refer to Figure 8-1).
SL2200 Printer (option -U)

The printer in the SL2200 monitor is a two-channel printer that provides automatic and manual recordings of parameter data on 50-mm roll paper. The printer prints recordings of parameters in alarm conditions, requested waveforms, and non-waveform data.

Loading Paper

The printer uses 50-mm wide by 30-m long rolls of thermal paper and has an automatic self-feed mechanism for threading the paper through the rollers (refer to Figure 8-2).

To load paper:

- Press the release button on the door.
- Open the paper tray door all the way.
- Snap the new roll into place with the paper feeding from the bottom as shown in Figure 8-2.
- Pull out 6 to 12 inches of paper.
- Close the door.
90449 Printer Module

The 90449 printer module (refer to Figure 8-3) is a two-channel printer that provides automatic and manual recordings of parameter data on 50-mm, fanfold paper. This printer module prints recordings of parameters in alarm conditions, in requested waveforms, and in non-waveform data.

Note:
This 90449 is not designed for use as a system printer and will not function correctly if used in this manner.

Loading Paper

When loading paper into the paper tray, the small, black, rectangular cue mark on the bedside printer paper must face out and be at the bottom of the tray. Each recording begins at the Z-fold perforation, and blank sheets are not placed between successive print requests.

Note:
Note the orientation of the small cue mark.
To load paper:

- Press the **Eject** button next to the PAPER OUT light.
- Pull out the plastic paper tray.
- Discard old cardboard retainer inside tray.
- Remove the label from the new paper, but keep the cardboard retainer in place around one end.
- Start inserting the paper into the paper tray, beginning with the cardboard retainer end.
- With the paper halfway into the paper tray, lift up the spring-loaded roller.
- Bring out the top fold of paper from under the top end of the cardboard retainer.
- Bring the top fold over the top of the spring-loaded roller.
- Release the spring-loaded roller onto the remainder of the paper.
- Insert the stack fully.
- Unfold the paper and position it over the top of the black roller at the end of the tray.
- Slide the tray completely back into the printer module.

---

**90469 System Printer Module**

The 90469 system printer module (refer to *Figure 8-5*) is a two- or four-channel printer that provides automatic and manual recordings of parameter data on 50-mm or 120-mm, Z-fold paper. The system printer module prints recordings of parameters in alarm conditions, requested waveforms, and non-waveform data. The system printer module can be used with either a bedside or the central monitor.

*Figure 8-5: 90469 system printer module*
91881 ICS Print Manager

ICS Print Manager enables you to print waveforms and associated annotation values and reports from a monitor to a network printer, instead of using the strip chart printer. Print Manager also retains the print jobs so that you can reprint them at a later time. Print Manager is an integrated component of ICS. Refer to the Intersys Clinical Suite Operations Manual (P/N 070-1167-xx, located on CD-ROM P/N 084-0601-xx) for more information on using ICS Print Manager.

Loading Paper

The system printer module has a slide-out, plastic tray that accepts packets of Z-fold paper. The two-channel printer uses 50-mm wide by 27-m long paper. The four-channel printer uses 120-mm wide by 45.7-m long paper. Each single sheet has a small, black, rectangular cue mark located along the edge that is used to load the paper into the tray (refer to Figure 8-6).

To load paper:
- Press the Eject button next to the PAPER OUT light.
- Pull out the plastic paper tray.
- Discard the old cardboard retainer inside the tray.
- Remove the label from the new paper, but keep the cardboard retainer in place around one end.
- Start inserting paper into the tray, beginning with the cardboard retainer end. Make sure that the black cue marks are on the top edge of the pages for the four-channel printer and on the bottom edge of the pages for the two-channel printer.
- Insert the stack fully.
- Unfold the paper and position it over top of the black roller at the end of the tray.
- Slide the tray completely back into the printer module.
Printer Key Functions

Printer control keys for the printer modules may be located on the front of the module. The printer can also be controlled by keys on the monitor itself.

To access printer control keys from the monitor:

- Touch NORMAL SCREEN.
- Press the printer controls or press the printer number key.
- Select the desired key.
Printing

Selecting Print Duration

Waveform Data

In the absence of an alarm condition, the origin of a print request determines the length of time waveform data (ECG, ART, RESP, etc.) are recorded. Recordings begin with a few seconds of data received just prior to the print request, followed by real-time data.

Recordings requested via the monitor are either 12 or 20 seconds in duration. This recording duration is selected by pressing the RECORDING DURATION key. (The RECORDING DURATION key will not appear if the recording duration has been preset and locked by your system administrator.)

Non-Waveform Data

The length of time required for the printer to print non-waveform data, such as graphs and data tables, depends on the complexity of the data and cannot be pre-determined.

Table 1: Key Descriptions

<table>
<thead>
<tr>
<th>Key</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLOW ON/OFF</td>
<td>Changes the print speed of waveform recordings to 6.25 mm/second. Pressing SLOW a second time returns the printer to the current system sweep speed. SLOW has no effect on the print speed of non-waveform recordings (such as data tables and graphics).</td>
</tr>
</tbody>
</table>
| CONTINUE             | • When the printer is offline, press this key to feed roll paper at 25 mm/second or to feed one sheet of perforated paper through the printer module.  
                        • When the printer is online and is currently printing a 12- or 20-second waveform recording, press CONTINUE to convert to a continuous recording. If you press CONTINUE, then the 12- or 20-second recording completes, followed by a horizontal line, and then the current data. The horizontal line appears, even on recordings that are not in a queue, but are the only request. |
| STOP RECORDING       | • Stops any printing currently in progress and moves to the next print request in the queue.  
                        • Stops any roll paper advance currently in progress.                                                                                                                                                  |
| PRINTER ON/OFF       | Takes the printer offline without turning the power OFF. Alarms and print requests will be ignored. A LED (located either in the key or on the front panel of system printer) illuminates when this function is selected. |
Selecting Recording Destination

The Recording Destination menu enables you to direct:

- Alarm recordings to a bedside printer, a network printer, or both.
- Other recordings to a bedside printer or a network printer, but not both.

**Note:**

*Twelve-lead ECG reports always print at the ICS printers, if available, regardless of the recording destination settings.*

---

**To generate automatic recordings on a bedside printer and to select parameters for alarm recording:**

- Touch MONITOR SETUP.
- Touch RECORDER CONFIG.
- Select RECORDING DESTINATION.
- Select a destination for the alarm recording.
- Touch PREVIOUS MENU.
- Touch ALARM PARAMS.
- Select parameter key(s) ON to initiate a recording in case of alarm. If the parameter key is OFF, no alarm recording is produced for that parameter in an alarm condition.

---

Recording Alarms

**Note:**

*Recordings in the process of printing cannot be interrupted or delayed by a new alarm condition.*

An alarm recording may be triggered whenever a parameter enters an alarm condition. These alarm recordings can be set to OFF so that a printer will not respond to an alarm condition (the alarm tone and accompanying alarm message are unaffected). Refer to *Automatic Recording of an Alarm* on page 6-11 for more details.

Alarm recordings begin with several seconds of pre-alarm waveform data and continue for as long as the alarm condition exists (for a minimum of 12 seconds).
Printing via Monitors

Waveform Data

Waveform data is printed using the RECORD key on the monitor.

Each time you touch RECORD on the monitor, the CONTINUOUS RECORD key appears and waveform parameter keys flash for up to two seconds. You must make your key selection within this two-second time period. Making a selection causes the parameter keys to flash for an additional two seconds. Once the parameter keys stop flashing, any waveforms that have been selected are automatically sent to the printer for recording.

Note:

• Requests for printing waveform data are limited to those waveform parameters currently displayed. The ECG split-view or full-view displays only include the first four displayed waveforms.

• If a parameter menu is left on the display, the CONTINUOUS RECORD key is not displayed.

Touch the RECORD key twice to display the Recording menu.

From the Recording menu you can:

• Print all parameters currently displayed by touching RECORD ALL.

• Initiate a preselected group of recordings by touching RECORD PRESELECTED A or RECORD PRESELECTED B.

• Select PRINT VITAL SIGNS to manually print the vital signs you have selected. Refer to Vitals Report on page 8-18 for additional information.

To start a manual recording via the monitor:

• Touch RECORD.
• Touch up to four flashing parameter keys.
• Touch CANCEL RECORD SELECTION(S) to terminate.
  -OR-
• Touch STOP RECORDING in the Printer Control menu to terminate.
To start a continuous recording via the monitor:

- Touch RECORD.
- Touch CONTINUOUS RECORD, then touch the desired parameter key (up to four, for each parameter to be continuously recorded).
- Touch CANCEL RECORD SELECTION to restart the selection process.

To stop a continuous recording via the monitor:

- Touch RECORD.
- Touch STOP CONT. RECORD.
  - OR-
- Touch STOP RECORDING in PRINTER CONTROLS.

**Group Recordings**

RECORD ALL and PRESELECTED A or B recordings are eight seconds in duration. The printer does not combine the parameters of different patients onto the same printout. Instead, it prints all the requested parameters for one patient before printing the parameters for the next patient.

To print group recordings via the monitor:

- Touch RECORD twice.
- Touch RECORD ALL.
  - OR-
- Touch RECORD PRESELECTED A or B.

**Non-Waveform Data**

The RECORD key is not used for printing non-waveform data on a central or bedside monitor. As a result, non-waveform information must be displayed before it can be printed. When you display non-waveform data on a central or a bedside monitor, a PRINT key appears. If the information cannot fit on the paper at one time, it is separated horizontally, printing first the top half and then the bottom half of the display.

A single non-waveform recording may take up as much room on the paper as two simultaneous waveform recordings.
Defining Preselected Recording Keys

The Preselected Recordings function (accessed through the Clinical level of Privileged Access) enables you to define which beds and parameters will be automatically recorded.

To define the PRESELECTED A and B parameters:

- Touch MONITOR SETUP.
- Touch PRIVILEGED ACCESS.
- Enter the Clinical password.
- Touch PRESELECTED RECORDINGS.
- Touch the key to be defined (PRESELECTED A or PRESELECTED B).
- Touch SELECT TYPE.
- Touch ALL/FIRST $n$ BEDSIDE PARAM(S) and use the arrow keys to cycle through parameter selections: ALL BEDSIDE PARAM(S) or FIRST $n$ BEDSIDE PARAM(S) (where $n$ is 1, 2, 4 or 8).
  - OR -
- Touch CONFIGURED PARAMETERS and toggle the desired parameters ON or OFF.
- Touch PREVIOUS MENU twice to define the remaining PRESELECTED key.

To define the PRESELECTED A and B beds:

- Touch MONITOR SETUP.
- Touch PRIVILEGED ACCESS.
- Enter the Clinical password.
- Touch PRESELECTED RECORDINGS.
- Touch the key to be defined (PRESELECTED A or PRESELECTED B).
- Touch SELECT BED.
- Select ALL SUBNETS.
  - OR -
- Select THIS SUBNET.
  - OR -
- Select THIS MONITOR.
- Touch PREVIOUS MENU twice to define the remaining PRESELECTED key.

To print preselected recordings:

- Touch RECORD twice.
- Touch RECORD PRESELECTED A or RECORD PRESELECTED B.
Paper Out Conditions

Caution:

- While printers are offline or out of paper, they ignore any new alarm that normally initiates a recording. Therefore, no alarm or requested recordings go into a queue.
- Removing a bedside or system printer module from the monitor to load paper causes an immediate loss of pending print requests.

All printers signal a paper-out condition by periodically sounding a tone. In addition, some module printers flash the PAPER OUT light, and the system printers display a LOCAL PRINTER PAPER OUT message. On the SL2200 printer, the PAPER OUT tone does not sound if the local alarm tone key is set to OFF.

After reloading paper in the system printer module, the paper-feed mechanism ejects a sheet of paper to verify proper paper feeding. For the paper-feed mechanism to function, you must leave the printer power ON while you are loading paper.

Vitals Report

The Vitals Report:

- Provides a manual report of selected parameter data on 50 mm roll paper.
- Only prints to the monitor’s internal printer.

Be sure to choose the data interval, the start time, and the parameters you wish to include on the report before printing.

Data Interval

Data can be printed at any of the available time intervals (1, 2, 3, 5, 10, 15, 30, and 60 minutes) and, optionally, whenever an NIBP reading is available (NIBP ON). If you select NIBP ON, you are not required to select an interval. If you do not choose an interval or NIBP ON before printing, the message VITALS REPORT ERROR prints.

Start Time

The report can include vital sign measurements taken in the past 1, 2, 4, 8, 12, or 24 hours.
Printing

Select Parameters

You must select the parameters you wish to have included in the report. If you choose a vital sign for which no data is available, then ??? appears on the report. Figure 8-7 shows an example of a vitals report. The blank Notes column appears in every report.

<table>
<thead>
<tr>
<th>Time</th>
<th>HR bpm</th>
<th>Resp BPM</th>
<th>Temp 1 °C</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>07:50</td>
<td>74</td>
<td>18</td>
<td>37.8</td>
<td></td>
</tr>
<tr>
<td>07:52</td>
<td>74</td>
<td>18</td>
<td>37.8</td>
<td></td>
</tr>
<tr>
<td>07:54</td>
<td>54</td>
<td>13</td>
<td>37.8</td>
<td></td>
</tr>
<tr>
<td>07:56</td>
<td>54</td>
<td>13</td>
<td>37.8</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 8-7: Vitals report*

To define the details of a report:

- Touch MONITOR SETUP.
- Touch RECORDER CONFIG.
- Touch VITALS SETUP.
- Touch DATA INTERVAL and select an interval for the report history.
- Touch PREVIOUS MENU.
- Touch START TIME and select a time period for the report history.
- Touch PREVIOUS MENU.
- Touch SELECT PARAMETERS and select the parameters you wish to include in the report.
- Touch PREVIOUS MENU.

To print a Vitals Report:

- Touch VITALS SETUP and then touch PRINT VITAL SIGNS.
  -OR-
- Touch RECORD twice and then touch PRINT VITAL SIGNS.
## Printing Troubleshooting Guide

### Clinical Situation Possible Cause Solution

<table>
<thead>
<tr>
<th>Message PAPER OUT appears</th>
<th>Printer is out of paper.</th>
<th>Load paper properly and verify that the printer door or printer tray is closed.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Printer door is open.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paper was loaded improperly.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Printer fails to print self-test data or page</th>
<th>Failed internal diagnostics.</th>
<th>Notify your biomed or a Spacelabs Healthcare field service engineer.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Message UNABLE TO RECORD THE REQUESTED CHANNEL appears</th>
<th>Printer is not ON.</th>
<th>Toggle PRINTER ON/OFF key.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Printer not selected by a system administrator.</td>
<td>Check with your hospital biomed or system administrator.</td>
</tr>
<tr>
<td></td>
<td>Printer is out of paper.</td>
<td>Load paper.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CONTINUOUS RECORD key is not displayed</th>
<th>Menu appears at the bottom of the display.</th>
<th>Touch NORMAL SCREEN, then touch RECORD.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Thermal printer recordings are blank</th>
<th>Z-fold or roll paper is loaded upside down.</th>
<th>Reload paper correctly.</th>
</tr>
</thead>
</table>
ECG

Directory of Keys

Setup

ECG MENU

ALARM LIMITS  SIZE  SETUP  LEAD CONTROL  DISPLAY FORMAT  SUSPEND PROCESSING  RELEARN  PRINT  REVIEW

Refer to page 9-3  Refer to page 9-3  Refer to page 9-2  Refer to page 9-2  This key changes to RESUME PROCESSING when processing is suspended.

Refer to page 9-2  Refer to page 9-3  Refer to page 9-3

ECG - SUSPEND PROCESSING

YES  NO

ECG - SETUP

Sweep SPEED  QRS TONE  MONITOR  PACED  CONFIG  RATE SOURCE  RESTORE SETTINGS  TRANSFER DATA

MONITOR EXTENDED

PACED YES  NO

CONFIG

RATE SOURCE

RESTORE SETTINGS

TRANSFER DATA

YES  NO

Restores all user-defined settings within this module

Select primary heart rate source

Enable alternate rate source(s)

ECG  ART  UA  SPO2

ART  UA  SPO2

ON  OFF  ON  OFF  ON  OFF

ECG - CONFIG

ADULT  INFANT

ARR

ON  OFF

Only available with Multiview I or II

ECG - QRS TONE

TONE

VOLUME ↓  VOLUME ↑

SPO2 PITCH

ON  OFF

ECG - SWEEP SPEED

50 mm/sec  25 mm/sec  12.5 mm/sec
Additional Functions

ECG MENU

- ALARM LIMITS (Refer to page 9-3)
- SIZE (Refer to page 9-3)
- SETUP (Refer to page 9-1)
- LEAD CONTROL
- DISPLAY FORMAT
- SUSPEND PROCESSING (Refer to page 9-1)
- RELEARN (Refer to page 9-3)
- PRINT (Refer to page 9-3)
- REVIEW (Refer to page 9-3)

ECG - RELEARN
- CLEAR MEMORY
- SAVE MEMORY

ECG - DISPLAY FORMAT
- FULL VIEW
  - ON
  - OFF
- SPLIT VIEW
  - ON
  - OFF
- 2 LEAD
  - ON
  - OFF
- CASCADE
  - ON
  - OFF
- RESP
  - ON
  - OFF
- VARITREND
  - ON
  - OFF
- NEXT VIEW

ECG - LEAD CONTROL
- 1st LEAD
  - V2
- 2nd LEAD
  - II
- AUTO LEAD SWITCH
  - ON
  - OFF
- SINGLE LEAD ALARM
  - ON
  - OFF
Alarms, Size, Printing, and Review

**ECG MENU**

<table>
<thead>
<tr>
<th>ALARM LIMITS</th>
<th>SIZE</th>
<th>SETUP</th>
<th>LEAD CONTROL</th>
<th>DISPLAY FORMAT</th>
<th>SUSPEND PROCESSING</th>
<th>RELEARN</th>
<th>PRINT</th>
<th>REVIEW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refer to page 9-1</td>
<td>Refer to page 9-2</td>
<td>Refer to page 9-2</td>
<td>Refer to page 9-1</td>
<td>Refer to page 9-2</td>
<td>Refer to page 9-2</td>
<td>Refer to page 9-2</td>
<td>Refer to page 9-2</td>
<td>Refer to page 9-2</td>
</tr>
</tbody>
</table>

**ECG - REVIEW**

<table>
<thead>
<tr>
<th>ST REVIEW</th>
<th>ARRHYTHMIA REVIEW</th>
<th>REPORT REVIEW</th>
<th>REAL TIME ST TREND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refer to page 11-1</td>
<td>Refer to page 10-1</td>
<td>Refer to page 12-1</td>
<td>Refer to page 11-1</td>
</tr>
</tbody>
</table>

**PRINT MENU**

<table>
<thead>
<tr>
<th>ARR CLASSES</th>
<th>ST SEGMENTS</th>
<th>ALL LEADS</th>
<th>PRINT ALL</th>
<th>CANCEL PRINT</th>
</tr>
</thead>
</table>

**ECG - SIZE**

| SIZE ↑ | SIZE ↓ | 1 mV | 1 mV/cm |

**ECG - ALARM LIMITS**

<table>
<thead>
<tr>
<th>ALARMS</th>
<th>HI = 130</th>
<th>LO = 40</th>
<th>ABN IN ROW = 5</th>
<th>ABN PER MIN = OFF</th>
<th>ST LEADS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>OFF</td>
<td>Only available with Arrhythmia turned ON</td>
<td>Refer to page 11-1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Overview

The ECG function provides a means for continuous monitoring of electrocardiographic signals. It can detect abnormal cardiac rhythms, including life-threatening arrhythmias such as asystole, ventricular fibrillation, and ventricular tachycardia. ECG monitoring is always performed on two leads.

The monitor’s input circuits are protected for use with electrosurgical equipment and defibrillators. Sensors may remain attached to the patient during defibrillation or while an electrosurgical unit is in use. However, the readings may be inaccurate during and shortly after use of such equipment. Cardiac pacemakers or other electrical stimulators do not affect and are not affected by operation of this unit.

The basic ECG software provides alarms for high and low heart rates, for ventricular fibrillation, and for asystole.

The Multiview I option provides enhanced arrhythmia detection and alarm capability. In addition to the detection and alarm capabilities of the basic ECG software, Multiview I also detects ventricular tachycardia, couplets, and single abnormal beats.

The Multiview II option expands arrhythmia detection to include pauses and tachycardias of a supraventricular origin. This option also offers storage capabilities so that trends of arrhythmia episodes, as well as dominant, ventricular-paced and AV-paced rhythms, can be reviewed, edited, and printed. Refer to Arhythmia on page 10-3 for additional information about the Multiview options.

Diagnostic ECG meets all the requirements and standards for electrocardiographic devices. It provides the ability to obtain a diagnostic 12-lead report as a function of the monitoring system. The 12-lead report is a set of diagnostic-quality electrocardiographic waveforms that accurately represent both the detailed cardiac cycle and the cardiac rhythm. Refer to 12-Lead Diagnostics on page 12-3 for additional information.
The ECG function:

- Detects and displays a waveform representing each cardiac cycle.
- Determines lead configuration options.
- Displays the heart rate (heart rate is computed from an average of eight beats, with a provision for being immediately updated should it change suddenly).
- Detects pacemaker pulses.
- Initiates ECG-related alarms when limits are violated.

Note:
To define your own default parameter settings and alarm settings, refer to the Ultraview SL Module Configuration Manager System Administration Guide (P/N 070-1245-xx).

You can display ECG waveforms for multiple leads. A message on the display identifies lead faults. If automatic lead switching is enabled, the system automatically switches to another appropriate lead to continue monitoring in the event of a lead fault.

Warnings and Cautions

This chapter includes warnings and cautions specifically related to ECG. Refer to Warnings and Cautions on page 23-5 in the Product Specifications chapter for cautionary disclosures that apply to electrodes and lead wires, defibrillators (including automatic implantable cardiac defibrillators), pacemakers, electrosurgical activity, several physiological parameters, or to the monitoring system itself.

ECG Setup

An alarm sounds and the CHECK SETUP key appears in the ECG waveform area when any of the following occurs:

- The monitor is powered ON.
- A monitor reset occurs.
- An ECG module is inserted.

Touch the CHECK SETUP key to dismiss and silence the alarm. Verify that the system configuration (for example, alarm limits or lead selection) is appropriate before you begin, or resume, monitoring.

Note:
The CHECK SETUP key does not appear when the Check Setup feature is disabled, and its associated alarm tone does not sound. Contact your system administrator to enable this feature.

ECG monitoring begins when the system detects a signal via connection of an ECG patient cable to the module or by installation of a battery into a telemetry transmitter.

ECG monitoring requires the following minimum conditions:

- ECG electrodes must be properly attached to the lead wires.
- The lead wires must be properly attached to the patient cable or the telemetry transmitter.
ECG

• The patient cable must be connected to the module.
• The module must be connected to a monitor that is powered ON.

Telemetry ECG monitoring requires the following additional minimum conditions:
• The telemetry transmitter must have a functional battery.
• The telemetry receiver module must be:
  - Connected to a monitor that is powered ON.
  - Configured to the same channel number as its corresponding telemetry transmitter. Refer to the Ultraview SL Operations Manual (P/N 070-1150-xx) for additional information.
  - Connected to a Spacelabs Healthcare diversity antenna.

Patient Preparation and Electrode Application

Use silver/silver-chloride electrodes or their equivalent, and always connect all electrodes required for a particular lead. Missing electrodes may result in the loss of the ECG waveform.

Note:
Use only Spacelabs Healthcare-recommended electrodes. Some electrodes may polarize and create large offset potentials. This can compromise recovery time after application of defibrillator pulses. Squeeze-bulb electrodes, commonly used for diagnostic ECG recordings, may be particularly vulnerable to this effect.

Noise on ECG signals, especially noise that resembles actual cardiac waveforms, is a frequent cause of false alarms. Some of this noise may be because of electrode positioning, patient movement or intermittent signal connections (either of electrode to skin or of lead wires to electrodes). You can eliminate some of this noise (and many of these false alarms) by paying careful attention to skin preparation and electrode application.

A patient cable or telemetry transmitter is usually color-coded to match the color of the lead wires. (Table 1 on page 9-8 lists electrode color and lead identifier codes.)

To set up ECG monitoring:

When attaching lead wires to the patient cable or telemetry transmitter, use the color coding and/or lead identifier code to ensure that the correct connections are made.

Most ECG electrodes are a column of conductive gel that is surrounded by an adhesive surface. The condition of the electrode’s gel column directly affects the quality of the ECG signal. For example, more noise appears on the ECG signal if gel is displaced (or air is trapped) when you apply an electrode to the patient. Key points to remember include:

• Before using electrodes, verify that they have not expired and that the conductive gel is not dry. Replace the electrodes if necessary.
• Always attach the electrode to its lead wire before applying the electrode to the patient (refer to Figure 9-1). Do not apply pressure directly over the electrode’s gel column.
• Press firmly around the outer edge of the electrode’s adhesive surface to ensure that the electrode is securely attached to the patient.
• To minimize muscle artifact, place electrodes over flat, non-muscular areas of the body (refer to Figure 9-2 and Figure 9-3). This is important for telemetry patients who are usually ambulatory.
• After electrodes and lead wires are attached, add a stress loop (a loop of lead wire taped close to its electrode) to minimize stress or pulling on the electrode itself. This will improve ECG signal quality, particularly for ambulatory patients.
ECG

**Note:**

*Spacelabs Healthcare recommends that electrodes be replaced after 24 to 48 hours of use.*

<table>
<thead>
<tr>
<th>To prepare the patient:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Wash the area with soap and water.</td>
</tr>
<tr>
<td>- If necessary, shave the area where you plan to position the electrodes.</td>
</tr>
<tr>
<td>- Clean the skin with alcohol.</td>
</tr>
<tr>
<td>- Dry the skin thoroughly.</td>
</tr>
<tr>
<td>- Abrade the skin.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To apply ECG electrodes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Attach an electrode to a lead wire.</td>
</tr>
<tr>
<td>- Apply the electrode to the patient’s skin.</td>
</tr>
</tbody>
</table>

**Figure 9-1: Electrode application**

1. Attach the electrode to the lead wire.
2. Apply the electrode to the skin.

<table>
<thead>
<tr>
<th>Table 1: Electrode Color and Identifier Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAMI Electrode Identifier</td>
</tr>
<tr>
<td>---------------------------</td>
</tr>
<tr>
<td>RA</td>
</tr>
<tr>
<td>LA</td>
</tr>
<tr>
<td>LL</td>
</tr>
<tr>
<td>RL</td>
</tr>
<tr>
<td>V1</td>
</tr>
<tr>
<td>V2</td>
</tr>
<tr>
<td>V3</td>
</tr>
</tbody>
</table>
Table 1: Electrode Color and Identifier Codes (continued)

<table>
<thead>
<tr>
<th>AAMI Electrode Identifier</th>
<th>AAMI Color Code</th>
<th>Electrode Placement</th>
<th>IEC Electrode Identifier</th>
<th>IEC Color Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>V4</td>
<td>Brown/Blue</td>
<td>5th Intercostal - Left Midclavicular</td>
<td>C4</td>
<td>White/Brown</td>
</tr>
<tr>
<td>V5</td>
<td>Brown/Orange</td>
<td>Left Anterior Axillary Line at V4</td>
<td>C5</td>
<td>White/Black</td>
</tr>
<tr>
<td>V6</td>
<td>Brown/Violet</td>
<td>Left Midaxillary Line at V4</td>
<td>C6</td>
<td>White/Violet</td>
</tr>
<tr>
<td>C</td>
<td>Brown</td>
<td>Chest</td>
<td>C</td>
<td>White</td>
</tr>
</tbody>
</table>

5 Electrodes I, II, III, aVR, aVL, aVF, V1 - V6
With a 5-electrode cable, chest electrodes must be appropriately relocated on patient’s chest to view other precordial leads.

4 Electrodes I, II, III, aVR, aVL, aVF

3 Electrodes I, II, III
With a 10-electrode cable, chest electrodes must be appropriately placed on patient’s chest to view precordial leads.

Figure 9-2: Adult electrode placement

<table>
<thead>
<tr>
<th>1</th>
<th>RL</th>
<th>6</th>
<th>V3 (C3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>V1 (C1)</td>
<td>7</td>
<td>V4 (C4)</td>
</tr>
<tr>
<td>3</td>
<td>RA</td>
<td>8</td>
<td>V5 (C5)</td>
</tr>
<tr>
<td>4</td>
<td>LA</td>
<td>9</td>
<td>V6 (C6)</td>
</tr>
<tr>
<td>5</td>
<td>V2 (C2)</td>
<td>10</td>
<td>LL</td>
</tr>
</tbody>
</table>
Maximum Impedance Change

Position RA and LA electrodes at the nipple level, anterior axillary line. Position LL below the diaphragm and preferably below the umbilicus.

Alternate Method

Position RA and LA electrodes at the 2nd intercostal space, midclavicular line. Position LL below the diaphragm, preferably below the umbilicus.

*Figure 9-3: Infant electrode placement*

Display Detail

*Note:

For telemetry display information, refer to the Ultraview SL Operations Manual (P/N 070-1150-xx) for additional information.*

Your ECG display view may differ from the illustrations in this section, depending on the following:

- The type of monitor you are using.
- The options in your module.
- Which functions you have enabled.
- The patient type selected.

Multiple ECG waveforms can be displayed at a bedside monitor by selecting either FULL VIEW, SPLIT VIEW, 2nd LEAD, or CASCADE.

A second waveform zone can display either a second ECG lead or a cascaded waveform from the first ECG zone (both cannot be displayed simultaneously). Data in a cascaded ECG waveform wraps from the first waveform zone into the second waveform zone to display 12 seconds of data for the selected lead.

While the cascaded waveform is displayed, the text in the parameter key for the second zone is STOP. Touching the STOP key freezes the waveform for viewing. While the display is frozen, the text in the key is START. Touching the START key resumes the waveform.
### ECG

The example shown in *Figure 9-4* has arrhythmia and ST analysis turned ON.

<table>
<thead>
<tr>
<th><strong>To display 6 or 12 leads (requires a 12-lead cable):</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch ECG.</td>
</tr>
<tr>
<td>• Touch DISPLAY FORMAT.</td>
</tr>
<tr>
<td>• Touch SPLIT VIEW / ON or FULL VIEW / ON.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>To display 2 leads:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch ECG.</td>
</tr>
<tr>
<td>• Touch DISPLAY FORMAT.</td>
</tr>
<tr>
<td>• Touch 2nd LEAD / ON.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>To cascade the ECG waveform:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch ECG</td>
</tr>
<tr>
<td>• Touch DISPLAY FORMAT.</td>
</tr>
<tr>
<td>• Touch CASCADE / ON.</td>
</tr>
<tr>
<td>• Touch STOP to freeze the ECG waveform.</td>
</tr>
<tr>
<td>• Touch START to restart the waveform.</td>
</tr>
</tbody>
</table>
Figure 9-4: Full-view display

1. ECG waveform for first lead
2. ECG parameter key
3. Abnormals-per-minute counter *
4. Display resolution (MONITOR or EXTENDED)
5. PACED mode indication (pacemaker detection is enabled)
6. Abnormals-per-minute alarm limit *
7. Abnormals-in-a-row alarm limit *
8. ECG rate alarm limits
9. QRS indicator (flashes once per detected beat)
10. Current heart rate
11. ST Segment levels for full-view display
12. ECG full-view display

* Only appears with the Multiview I or II option in ADULT mode with Arrhythmia detection enabled.

Note:
If the Enhanced Vital Signs display feature is enabled, you can view SpO₂, respiration rate, and noninvasive pressure in the ECG zone on central or remote bedside monitors. However, alarm status information for these parameters does not appear.
Selecting ADULT or INFANT Mode

The ECG function provides both ADULT and INFANT operational modes. ECG alarm limits are set based on your selection of ADULT or INFANT. For ECG detection, the QRS amplitude must be at least 0.20 mV in an adult and 0.15 mV in an infant.

Caution:
When INFANT is selected, alarm activation for ECG and respiration can be delayed for up to three minutes. Closely observe the patient during this period.

To specify the patient type:

• Touch ECG.
• Touch SETUP.
• Touch CONFIG.
• Select ADULT or INFANT.

Monitoring Patients with Pacemakers

When monitoring a patient with a pacemaker, the Paced feature prevents pacemaker pulses from being counted as actual beats. Specialized circuitry removes the pacemaker pulses from the ECG signal and replaces them with pacemaker flags.

To monitor patients with pacemakers:

• Touch ECG.
• Touch SETUP.
• Select PACED / YES.

Permanent transvenous pacemakers employing a bipolar lead system can obtain a capture of the cardiac muscle at a much lower current than those with unipolar lead systems. For optimal paced rhythm detection, the pacemaker pulse and QRS complex must be of sufficient voltage.

To determine if the monitor is correctly detecting the pacemaker pulses, verify that the Paced feature is activated. Each paced beat should have a pacemaker flag of a contrasting color superimposed on the ECG waveform at the appropriate point prior to the QRS complex. If flags are not consistently observed, cycle through the available leads to find a better lead, or reposition electrodes to optimize pacemaker detection. Check the amplitude of the QRS complex by inserting a 1-mV calibration pulse into the ECG waveform (refer to Adjusting Waveform Size on page 9-17).
Warning:
Some rate-adaptive implanted pacemakers alter their rate based on the patient's Minute Volume. These pacemakers may occasionally be confused by the signal that a patient monitor uses to measure the patient's thoracic impedance (to determine respiration rate). When this occurs, these pacemakers may begin pacing at their maximum programmed rate. Turning the RESP channel OFF can prevent this.

Note:
- To select the optimal leads for monitoring patients with pacemakers, cycle through the available leads. If pacemaker pulses are not detected, or if the heart rate is incorrectly counted, select another lead or change electrode position.
- In telemetry monitoring, pacemaker pulses are detected on Lead II.
- If the interval between the pacemaker pulse and the QRS complex is greater than 150 milliseconds, the beat is considered to have originated in the atria and is not classified as a paced beat.
- Refer to Warnings and Cautions on page 23-5 for cautionary disclosures related to defibrillators (including implantable cardiac defibrillators), pacemakers, and electrosurgical activity.

Verifying the Capture Threshold
When using temporary transvenous pacemakers, verify the pacemaker's capture threshold on a regular basis (refer to your hospital protocol for frequency and procedure). The pacemaker flag that is substituted by the monitor does not represent the true amplitude of the detected pacemaker pulse.

To verify the capture threshold:
1. Temporarily disable the Paced feature.
2. Switch the display mode to EXTENDED. Changing the sweep speed to 50 mm/sec improves visualization of the pacemaker pulse amplitude.
3. Return to the MONITOR mode.
4. Reactivate the PACED mode.
5. Reset the desired sweep speed.

Refer to Changing the Display Resolution on page 9-19 for additional information about the MONITOR/EXTENDED key.
Enabling and Adjusting Alarms

Events that can cause an ECG alarm include:

- High or low rate
- Ventricular fibrillation (VFIB)
- Asystole

*Table 2 on page 9-16 describes the conditions that may initiate an alarm. With the Multiview I or II option, additional conditions that can cause an alarm include:*

- Abnormals in a row (couplets or runs)
- Abnormals per minute
- Tachycardia (of supraventricular origin)

Refer to *Arrhythmia* on page 10-3 for details concerning arrhythmia alarms. Refer to *ST Analysis* on page 11-3 for details concerning ST alarms. Refer to *Setting Alarm Limits on page 6-7* for details on operating system alarms.

To verify the capture threshold:

- Touch ECG.
- Touch SETUP.
- Touch PACHED / NO.
- Touch EXTENDED.
- Touch SWEEP SPEED.
- Touch 50 mm/sec.
- Perform the capture threshold verification procedure according to your protocol.
- Touch ECG.
- Touch SETUP.
- Touch PACHED / YES.
- Touch MONITOR.
- Touch SWEEP SPEED.
- Select the desired speed.

To adjust rate alarms:

- Touch ECG.
- Touch ALARM LIMITS.
- Touch HI or LO =.
- Use the arrow keys to adjust.
**Warning:**

- If ECG monitoring is interrupted and subsequently resumed during an asystole event, then five or six seconds will elapse prior to the display of the asystole alarm and the alarm tone.
- If ECG monitoring is initiated during an asystole event, then 10 or 11 seconds will elapse prior to the display of the asystole alarm and the alarm tone.

**Note:**

If the alarm limits for high rate, low rate, ABN PER MIN, or ABN IN ROW appear in reverse video, then the Alarm Tone and Alarm Recording features are disabled for the indicated alarm.

During a learn sequence, IN LEARN appears on the monitor display while the system establishes the heart rate and identifies the patient’s predominant beat morphology. At the completion of the learn sequence, the rate alarm limits are set based on this learned heart rate (if they were not previously set to FIXED in the Module Configuration Manager). You can adjust these limits up or down as needed.

<table>
<thead>
<tr>
<th>Table 2: ECG Alarms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alarm</strong></td>
</tr>
<tr>
<td>VFIB</td>
</tr>
<tr>
<td>Asystole</td>
</tr>
<tr>
<td>High Heart Rate</td>
</tr>
<tr>
<td>Low Heart Rate</td>
</tr>
<tr>
<td>Chan 1 and 2 - Leads Off</td>
</tr>
<tr>
<td>Chan 1 - Lead Off</td>
</tr>
<tr>
<td>Chan 2 - Lead Off</td>
</tr>
<tr>
<td>Rate Source Unavailable</td>
</tr>
<tr>
<td>Noisy Signal</td>
</tr>
<tr>
<td>Low ECG Voltage</td>
</tr>
</tbody>
</table>
Selecting ECG Leads

When you change lead selections, the new waveform displays and the learn sequence is automatically initiated. If you change lead selections while processing is suspended, the module initiates the learn sequence when you resume processing. Changing your selection for the first lead may change the selection for the second lead.

When you select a precordial lead, a message appears, describing the proper location for the chest electrode. For example, if you select V1, the message (C) 4TH INTERCOSTAL SPACE, RIGHT STERNAL BORDER appears. No message appears when you choose to display a limb or augmented lead (for example, I, II, III, AVR, AVL, or AVF).

**Warning:**

*ECG alarms for ventricular fibrillation and asystole remain active while the patient's rate and morphology are being learned (for example, following a lead switch or use of the RELEARN feature). ECG alarms for high rate, low rate, run, couplet, abnormal/minute, and tachycardia are not reactivated until the learning process ends.*

To change the lead selection:

- Touch ECG.
- Touch LEAD CONTROL.
- Touch 1st LEAD or 2nd LEAD.
- Select lead.

Adjusting Waveform Size

You can increase or decrease the display size of the ECG waveform without affecting the signal gain.

When you touch the 1 mV/cm key, the ECG waveform size is set to one millivolt per centimeter. This standardizes the waveform to aid in accurately viewing QRS complexes for ST segment deviation.

**Note:**

*Waveform sizes for all leads are adjusted simultaneously when you display multiple ECG leads in either SPLIT-VIEW or FULL-VIEW mode.*

To adjust waveform size and/or check the ECG amplitude:

- Touch ECG.
- Touch SIZE.
- Use the arrow keys to adjust.
  - OR-
- Touch the 1 mV/cm key to standardize.
ECG

Touching the 1 mV CAL key inserts a one-millivolt amplitude calibration pulse into all ECG waveforms. Use this calibration pulse as a reference to determine whether the amplitude of the ECG waveform exceeds the minimum voltage threshold.

Adjusting Sweep Speed

The sweep speed determines the speed at which the ECG waveform moves across the display. Changes to SWEEP SPEED affect all displayed ECG waveforms.

*Note:*
Changing the ECG sweep speed may also change the speed of the invasive pressure waveforms. Refer to Adjusting Waveform Size and Sweep Speed on page 14-7 for additional information.

<table>
<thead>
<tr>
<th>To adjust the sweep speed:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch ECG.</td>
</tr>
<tr>
<td>• Touch SETUP.</td>
</tr>
<tr>
<td>• Touch SWEEP SPEED.</td>
</tr>
<tr>
<td>• Select the desired speed.</td>
</tr>
</tbody>
</table>

Adjusting Tones

**QRS Tone**

The QRS tone is the sound the monitor generates with each detected R wave. When the QRS tone is ON, you can adjust the volume and select to modulate the tone with the current SpO₂ value.

<table>
<thead>
<tr>
<th>To set the QRS tone:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch ECG.</td>
</tr>
<tr>
<td>• Touch SETUP.</td>
</tr>
<tr>
<td>• Touch QRS TONE.</td>
</tr>
<tr>
<td>• Touch TONE / ON.</td>
</tr>
<tr>
<td>• Use the VOLUME arrow keys to adjust the volume.</td>
</tr>
</tbody>
</table>

**SpO₂ Pitch**

The monitor uses the default pitch for the QRS tone when the SpO₂ pitch tone is OFF. When you enable the SpO₂ pitch tone, the monitor modulates the pitch of the QRS tone higher or lower depending on the current SpO₂ value. When the QRS tone is OFF, the SpO₂ pitch modulation automatically turns OFF.
Changing the Display Resolution

The MONITOR/EXTENDED key determines the display resolution of the ECG waveforms.

- MONITOR mode reduces the frequency range to filter out more noise for better viewing.
- EXTENDED mode displays a broader frequency range with more noise.

<table>
<thead>
<tr>
<th>Key</th>
<th>Telemetry</th>
<th>Non-telemetry</th>
</tr>
</thead>
<tbody>
<tr>
<td>MONITOR</td>
<td>0.5 to 30 Hz</td>
<td>0.5 to 40 Hz</td>
</tr>
<tr>
<td>EXTENDED</td>
<td>0.05 to 30 Hz</td>
<td>0.05 to 150 Hz</td>
</tr>
</tbody>
</table>

Note: If you change the display resolution, you do not change the waveform bandwidth used to analyze the ECG signals for arrhythmia and ST segment level.

To change the display resolution:
- Touch ECG.
- Touch SETUP.
- Select MONITOR or EXTENDED.

Selecting Primary and Alternate Heart Rate Sources

You can select a primary rate source and enable alternate rate sources. Rate sources include ECG, ART (arterial pressure), UA (umbilical artery), and SpO2.

If you enable one or more alternate sources, a heart rate appears (if available) from either the primary or an alternate source. If you do not enable any alternate sources, a heart rate will only appear if the primary rate source is available. If a heart rate is not available from any source, the message HR UNAVAILABLE appears in the ECG waveform zone and question marks (???) replace the rate value.

Caution:
When you use an alternate heart rate source, Cardiovascular Artifact (CVA) detection is disabled for the respiration channel.

Note:
- If you use ART as an alternate heart rate source, Spacelabs Healthcare recommends setting up each monitor with only one arterial pressure channel.
- Use of SpO2 as the primary heart rate source is not recommended, because SpO2 is a frequent source of false alarms.
Suspending/Resuming ECG Processing

When you touch YES in the **Suspend Processing** menu, ECG and respiration waveforms continue to display, but no processing occurs. If you touch NO, then the display returns to the **ECG** menu without affecting ECG and respiration processing.

### To suspend ECG processing:
- Touch ECG.
- Touch SUSPEND PROCESSING.
- Touch YES.

### To resume ECG processing:
- Touch ECG.
- Touch RESUME PROCESSING.
- Touch YES.

**When ECG processing is suspended:**
- The SUSPEND PROCESSING key changes to RESUME PROCESSING.
- The message **ECG PROCESSING SUSPENDED** appears in the ECG waveform zone. In modules with the respiration option, the message **RESP PROCESSING SUSPENDED** appears in the respiration waveform zone.
- Question marks replace the heart rate immediately and replace the ST segment value after 30 seconds. If an alternate heart rate source is available, the new heart rate is displayed. Question marks (???) continue to display for the ST segment value.
- Patient Data Logger displays questions marks (???) for both heart rate and ST segment value.
ECG

- The message *ECG ALM OFF* replaces the alarm limits, and keys in the **ECG Alarm Limits** menu are disabled (if no alternate rate source is available).
- For multiparameter telemetry, SpO₂ and/or NIBP alarm surveillance is still active if already enabled by the user. Alarm messages related to NIBP and SpO₂ prevent the ECG *PROCESSING SUSPENDED* message from appearing.

Printing ECG Data

**All printouts of ECG data are annotated with the following:**
- Bed identification
- Time and date of printout
- Lead designator

Depending on the type of printer, the ALL LEADS recording can be printed on a single page or as consecutive two- or four-channel recordings. Waveform data are printed for 6.25 seconds for all available leads.

Refer to *Acquiring and Printing 12-Lead Reports* on page 12-4 for information on printing 12-lead reports.

<table>
<thead>
<tr>
<th>To print recordings of all leads:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch ECG.</td>
</tr>
<tr>
<td>• Touch PRINT.</td>
</tr>
<tr>
<td>• Touch ALL LEADS.</td>
</tr>
</tbody>
</table>

Restoring Default Settings

The RESTORE SETTINGS key changes the user-configurable settings for all parameters in the module to the defaults previously stored as user settings (refer to the *Ultraview SL Module Configuration Manager System Administration Guide*, P/N 070-1245-xx). After the default settings are restored, the system initiates a learn sequence. Following the learn sequence, rate, and ST alarm limits are reset.

<table>
<thead>
<tr>
<th>To restore default settings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch ECG.</td>
</tr>
<tr>
<td>• Touch SETUP.</td>
</tr>
<tr>
<td>• Touch RESTORE SETTINGS.</td>
</tr>
<tr>
<td>• Select YES.</td>
</tr>
</tbody>
</table>
ECG Problem Solving

If ECG signal quality is poor (indicated by wandering baseline, excessive noise, or muscle or respiration artifact), try the following solutions:

- Ensure that silver/silver-chloride electrodes are being used.
- Ensure that the patient's skin is properly prepared.
- Ensure that all electrodes are firmly attached and in good condition.
- Ensure that the electrodes are positioned on a flat, non-muscular area.
- Ensure that lead wires are properly fastened and in good condition.

If these actions fail to resolve the problem, select a different lead.

Lead Fault Indication

The message CHECK XX (where XX identifies the failed or missing electrode) appears in the ECG waveform zone if a lead fault occurs.

If automatic lead switching is enabled, another lead is automatically selected so that monitoring is uninterrupted.

A LEADS OFF message appears if automatic lead switching is disabled.

Noise Detection

A NOISY SIGNAL message appears in the ECG waveform zone if noise is detected. If both the first and second lead are noisy, the module suspends processing temporarily. If the noise persists for 10 seconds, the system initiates an alarm. The message and alarm cease when the noise disappears.

Note:

- If monitoring is interrupted because of overload or saturation of the input amplifiers, including overload caused by a defibrillator discharge, the ECG waveform is displayed as an out-of-range signal accompanied by a NOISY SIGNAL or HR UNAVAILABLE message. If the overload or saturation condition persists, the ECG waveform is displayed as a flat-line signal accompanied by an ASYSTOLE message.
- If the displayed waveform does not appear noisy, but the NOISY SIGNAL message persists, check all leads for noise before calling a qualified field service engineer.

False Alarms

Careful attention to skin preparation and electrode application, especially during setup, will reduce false alarms.

If false alarms occur, check for the following:

- Excessive noise on the signal (the most common cause of false alarms). Electrodes that are placed incorrectly over muscles, or a poor lead connection, can cause significant noise when the patient moves.
- Heart rate limits set too close to patient's heart rate. Adjust the limits as necessary.
ECG

- ECG amplitude drops below the R-wave detection threshold level. This causes false low rate alarms. Reposition the electrodes to obtain a QRS amplitude of at least 0.20 mV for adults and at least 0.15 mV for infants.

- QRS frequency components and shape are unsatisfactory for accurate beat detection and classification. Make necessary changes in electrodes, electrode sites, or lead selection to restore a good signal.

- VFIB resembles previously classified abnormal beats. This may cause VFIB to be detected as a RUN. If this occurs, use the waveform display as the primary indication of the patient’s condition.

- The system does not recognize some beats as morphologically different from the learned dominant beat. You may be able to improve performance by changing electrode positions or switching to a lead setting that provides better differentiation between the dominant and abnormal beats.


## ECG Troubleshooting Guide

**Caution:**

Status messages indicate a problem or condition that may affect accurate monitoring values. Do not ignore these messages. Correct any fault before continuing.

<table>
<thead>
<tr>
<th>Clinical Situation</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AC noise</strong></td>
<td>■ Display resolution is set to EXTENDED mode.</td>
<td>■ Select MONITOR mode.</td>
</tr>
<tr>
<td></td>
<td>■ Electrodes are dry.</td>
<td>■ Repeat skin preparation and apply new moist electrodes.</td>
</tr>
<tr>
<td></td>
<td>■ ECG cable is entwined with other electrical devices.</td>
<td>■ Separate ECG cable from all other cables.</td>
</tr>
<tr>
<td><strong>Baseline wanders</strong></td>
<td>■ Patient is moving excessively.</td>
<td>■ Use stress loops to secure lead wires and cable to the patient.</td>
</tr>
<tr>
<td></td>
<td>■ Respiration artifact.</td>
<td>■ Select another lead or reposition the electrodes.</td>
</tr>
<tr>
<td></td>
<td>■ Electrodes are dry.</td>
<td>■ Repeat skin preparation and apply new moist electrodes.</td>
</tr>
<tr>
<td><strong>Low amplitude ECG</strong></td>
<td>■ Skin is improperly prepared.</td>
<td>■ Abrade skin and reapply electrodes.</td>
</tr>
<tr>
<td></td>
<td>■ Selected lead is not showing the QRS complex with greatest amplitude.</td>
<td>■ Check the 12-lead ECG to determine a better monitoring lead and/or reposition electrodes.</td>
</tr>
<tr>
<td></td>
<td>■ Electrodes could be positioned too close to bone or muscle mass.</td>
<td>■ Select another lead or reposition electrodes.</td>
</tr>
<tr>
<td><strong>ECG won’t learn</strong></td>
<td>■ ECG signal is too noisy for initialization.</td>
<td>■ Improve signal quality by repeating skin preparation and/or repositioning electrodes.</td>
</tr>
<tr>
<td></td>
<td>■ ECG voltage is below threshold. <em>ECG VOLTAGE TOO LOW</em> message may appear.</td>
<td>■ Perform the following steps as needed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1  Check cables, lead wires, and electrodes, then relearn patient rhythm.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2  Change lead or reposition electrodes.</td>
</tr>
</tbody>
</table>
## ECG

<table>
<thead>
<tr>
<th>Clinical Situation</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>No ECG waveform</td>
<td>■ Improper attachment of the ECG cable to the module/transmitter, or leads off.</td>
<td>■ Remove and then reconnect the ECG cables to the module, or reconnect the leads to the patient cable or transmitter.</td>
</tr>
<tr>
<td></td>
<td>■ Module is not seated into the monitor or remote housing.</td>
<td>■ Remove and then reinsert the module, or replace the module.</td>
</tr>
<tr>
<td>Excessive alarms</td>
<td>■ Electrodes are dry.</td>
<td>■ Repeat skin preparation and apply new moist electrodes.</td>
</tr>
<tr>
<td></td>
<td>■ Alarm limits are set too close to patient’s normal heart rate.</td>
<td>■ Readjust alarm limits.</td>
</tr>
<tr>
<td></td>
<td>■ Excessive interference: patient cable or wires are routed too close to other electrical devices.</td>
<td>■ Reroute cables and leads.</td>
</tr>
<tr>
<td></td>
<td>■ Excessive patient movement or muscle tremor.</td>
<td>■ Reposition electrodes and use stress loops to secure lead wires and cable to the patient.</td>
</tr>
</tbody>
</table>
Arrhythmia

Directory of Keys

Arrhythmia Review

ECG

ECG MENU

ALARM LIMITS

Refer to page 10-2

RELEARN

REVIEW

ECG - RELEARN

CLEAR MEMORY

SAVE MEMORY

ECG - REVIEW

ARRHYTHMIA REVIEW

REVIEW

DOM

RUN 1

CPL 0

ABN 3

TACH

PAUSE 8

PACED 8

ARRHYTHMIA - REVIEW

LEAD

VI

II

ALARM

YES

NO

CLEAR

MERGE

CLASS TREND

GROUP TREND

PRIOR CLASS

NEXT CLASS

PRINT

GROUP TREND

TIMEBASE 6 HOURS

CURSOR

L

R

↓

PRIOR CLASS

NEXT CLASS

PRINT

CLASS TREND

TIMEBASE 6 HOURS

INCLUDE

YES

NO

CURSOR

L

R

↓

PRIOR CLASS

NEXT CLASS

PRINT

Merge these classes or select another class

MERGE CLASSES

MERGE TRENDS

PRIOR CLASS

NEXT CLASS

Do you wish to clear the entire class or the most recent occurrence?

ENTIRE CLASS

LAST EVENT
### Alarm Limits

#### ECG MENU

<table>
<thead>
<tr>
<th>ALARM LIMITS</th>
<th>RELEARN</th>
<th>REVIEW</th>
</tr>
</thead>
</table>

Refer to page 10-1

#### ECG - ALARM LIMITS

<table>
<thead>
<tr>
<th>ALARMS</th>
<th>HI =</th>
<th>LO =</th>
<th>ABN IN ROW =</th>
<th>ABN PER MIN =</th>
<th>↑</th>
<th>↓</th>
<th>SINGLE ST =</th>
<th>MULTI ST =</th>
<th>ST LEADS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>130</td>
<td>40</td>
<td>5</td>
<td>OFF</td>
<td></td>
<td></td>
<td>1.00</td>
<td>0.50</td>
<td></td>
</tr>
</tbody>
</table>

Only available with ST Analysis option
## Arrhythmia

### Overview

Two levels of arrhythmia detection and review are available in the following options:

The **Multiview I** option provides enhanced arrhythmia detection and alarms for ventricular tachycardia, couplets, and single abnormal beats. It also provides detection and alarm capabilities for high and low heart rates, ventricular fibrillation, and asystole.

The **Multiview II** option expands arrhythmia detection to include pauses and tachycardias of a supraventricular origin. This option also offers storage capabilities. Trends of arrhythmia episodes, as well as dominant and paced rhythms, can be reviewed, edited, and printed.

**Note:**

- No arrhythmia detection system can correctly detect and classify all arrhythmias 100% of the time. Use sound clinical judgment when monitoring patients with arrhythmias.

- To define your own default parameter settings and alarm settings, refer to the Ultraview SL Module Configuration Manager System Administration Guide (P/N 070-1245-xx).
Setting Up Arrhythmia Monitoring

With the Multiview I or II option, the ARR ON/OFF key enables or disables arrhythmia detection functions. Arrhythmia detection must be enabled to establish a new dominant waveform (refer to Relearning the Dominant Waveform on page 10-7 for additional details).

<table>
<thead>
<tr>
<th>To set up arrhythmia monitoring:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Set up system and patient for standard ECG monitoring.</td>
</tr>
<tr>
<td>• Touch ECG.</td>
</tr>
<tr>
<td>• Touch SETUP.</td>
</tr>
<tr>
<td>• Touch CONFIG.</td>
</tr>
<tr>
<td>• Ensure ADULT is selected.</td>
</tr>
<tr>
<td>• Select ARR / ON.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To disable arrhythmia detection:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch ECG.</td>
</tr>
<tr>
<td>• Touch SETUP.</td>
</tr>
<tr>
<td>• Touch CONFIG.</td>
</tr>
<tr>
<td>• Select ARR / OFF.</td>
</tr>
</tbody>
</table>

When you turn arrhythmia detection ON:
• IN LEARN appears above the ECG waveform in the first zone.
• The RELEARN key is present in the ECG menu.
• The ABN IN ROW and ABN PER MIN keys are present in the Alarm Limits menu.
• ECG alarms are momentarily deactivated until the learn sequence completes.
• Rate and ST alarm limits are initialized.
• Abnormals in a Row and Abnormals per Minute alarm limits are initialized.

When you turn arrhythmia detection OFF:
• IN LEARN appears above the ECG waveform in the first zone.
• No arrhythmia detection features or menus are displayed.
• ECG alarms are momentarily deactivated until the learn sequence completes.
• Rate and ST alarm limits are initialized.
Classifying Events

Table 1 describes the arrhythmias detected with the Multiview I or II options.

<table>
<thead>
<tr>
<th>Type of Class</th>
<th>Defining Characteristics</th>
<th>Prematurity Required</th>
<th>Max # of Classes Allowed</th>
<th>Type of Waveform Storage (Multiview II only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABNORMAL **</td>
<td>One beat of abnormal morphology</td>
<td>No</td>
<td>12</td>
<td>Qualifying occurrence (5th) + most recent</td>
</tr>
<tr>
<td>COUPLET **</td>
<td>Two consecutive beats of abnormal morphology</td>
<td>No for the first beat; yes for the second beat *</td>
<td>32</td>
<td>Qualifying occurrence (3rd) + most recent</td>
</tr>
<tr>
<td>RUN</td>
<td>Three or more consecutive beats of abnormal morphology</td>
<td>No for the first beat; yes for each subsequent beat *</td>
<td>32</td>
<td>Six seconds of each occurrence. First in, first out. Saves longest Run and Pause.</td>
</tr>
<tr>
<td>PAUSE</td>
<td>An R-R interval that is 1.8 times (or 80%) longer than normal</td>
<td>No</td>
<td>NA</td>
<td>Six seconds of last occurrence stored as a pause when following normal beats</td>
</tr>
<tr>
<td>ASYSTOLE</td>
<td>Absence of QRS for five seconds or more</td>
<td>No</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>PACED</td>
<td>1 pacemaker spike followed by a QRS (within 150 ms)</td>
<td>No</td>
<td>1</td>
<td>First paced beat occurrence each minute (PACED key must be set to YES)</td>
</tr>
<tr>
<td>AV PACED</td>
<td>2 pacemaker spikes followed by a QRS</td>
<td>No</td>
<td>1</td>
<td>First paced beat occurrence each minute (PACED key must be set to YES)</td>
</tr>
<tr>
<td>TACH (SUPRA VENTRICULAR)</td>
<td>≥5 or more premature dominant beats in a row</td>
<td>Yes *</td>
<td>1</td>
<td>Six seconds of last occurrence</td>
</tr>
<tr>
<td>VFIB</td>
<td>NA</td>
<td>No</td>
<td>1</td>
<td>Six seconds of last occurrence</td>
</tr>
<tr>
<td>DOMINANT **</td>
<td>NA</td>
<td>NA</td>
<td>1</td>
<td>Qualifying occurrence (10th) + most recent each minute</td>
</tr>
</tbody>
</table>

* Prematurity is defined as an instantaneous R-R interval that is:
  - 15% premature compared to the average R-R interval.
  - ≤666 ms for couplets and runs, and ≤500 ms for tachycardias of a supraventricular origin.

** Template-forming classes (class trends are only available for template-forming classes).
Learning and Relearning

Learning the Dominant Waveform

During the learn sequence:

- IN LEARN appears on the monitor display.
- The system determines the heart rate and begins to classify each beat.
- Rate alarms are set based on this learned heart rate (if they have not been previously set to FIXED in the Module Configuration Manager).
- The first non-premature beat that occurs ten times is established as the dominant class.

When the learn sequence is completed, the IN LEARN message disappears from the monitor display.

Examples of actions that initiate a learn sequence are:

- Power ON
- Module insertion
- Changing patient type (adult/infant)
- Enabling or disabling arrhythmia detection
- Patient admission via the Admit/Discharge menu

The system does not classify a paced beat as the dominant class. If the patient is 100% paced and there is no dominant class at the end of the learn sequence, the first single non-paced beat detected five times becomes the dominant class.

Detecting Abnormal Beats

The system compares each incoming beat with the dominant class. It examines morphology and the intervals between both the previous and the following beats to determine whether the beat matches the dominant. If the system determines that the beat is abnormal, it compares the new beat with each of the abnormal shapes that have been detected since the learn sequence was completed. If the current beat fails to match any of the existing shapes (and after five occurrences), the system classifies it as a new abnormal class.

Detecting Pauses

The system classifies an R-R interval that is 1.8 times (or 80%) longer than the average R-R interval as a pause. The system does not count two, consecutive, long R-R intervals both in the Pause class. Instead, it assumes that a sudden rate change occurred and updates the heart rate immediately.

The last beat detected preceding the pause appears to the left of center in the Pause class.

Detecting Paced Beats

Once learning is completed, a Paced class is created when the system detects the first paced beat if the Paced feature is enabled in the ECG Setup menu.
Arrhythmia

The system identifies two different types of paced beats:

- **Paced** — indicates ventricular-paced beats (defined as a QRS complex) that are preceded by a single pacemaker pulse.
- **AV-paced** — indicates beats that are preceded by two pacemaker pulses.

The QRS complex must follow the pacemaker pulse within 150 ms for the beat to be classified into either paced class. If the pacemaker pulse precedes the QRS complex by more than 150 ms, the beat may be triggered by an atrial pacemaker and is not classified in either paced class.

Relearning the Dominant Waveform

You can relearn the dominant rhythm and establish a new dominant at any time during monitoring. After touching the RELEARN key, you can either clear the memory or save the memory. Once a selection is made, the relearn sequence is initiated. During this sequence, ECG alarms are suspended.

To relearn the dominant waveform:

- Touch ECG.
- Touch RELEARN.
- Select SAVE MEMORY or CLEAR MEMORY.

**Warning:**

ECG alarms for ventricular fibrillation and asystole remain active while the patient’s rate and morphology are being learned (for example, following a lead switch or use of the RELEARN feature). ECG alarms for high rate, low rate, run, couplet, abnormal/minute, and tachycardia are not reactivated until the learning process ends.

Select CLEAR MEMORY to clear all arrhythmia and ST segment data and reset the Abnormals-per-Minute, Abnormals-in-a-Row, and ST segment alarms. Upon completion of the learn sequence, ECG alarms are enabled and rate alarm limits are reset.

Select SAVE MEMORY to save all previously acquired arrhythmia and ST segment data. The old dominant is labeled as EXDOMINANT and is stored as an abnormal class. Once the learn sequence is completed, ECG alarms are enabled and rate alarms are reset. The Abnormals-per-Minute and Abnormals-in-a-Row alarms remain unchanged. If ST segment level alarms are enabled prior to the relearn sequence, they will be reset.

Automatic Dominant Class Update

The system automatically learns the patient’s predominant morphology. It also dynamically updates the dominant class as the patient’s morphology changes. The system uses the following rules to update the dominant class:

An abnormal class automatically becomes the new dominant class when it occurs:

- More frequently than 50% of all beats in the previous 60 seconds.
- Three beats more frequently than the current dominant during that period.
Arrhythmia

The old dominant is put into an abnormal class and given the status EXDOMINANT. This class can become dominant again and has the same characteristics as any other active class.

The message *NEW DOMINANT* appears above the ECG waveform for 60 seconds after the new dominant is established.

Display Detail

The system stores and displays arrhythmia review data in two categories (refer to *Figure 10-1*):

- **Non-template-forming class** — displays a waveform that is 6.25 seconds in length and is representative of the most recent occurrence.
- **Template-forming class** — displays two waveforms:
  - The waveform on the left is 1.25 seconds in length. The arrhythmia that originated the class is centered.
  - The waveform on the right is 4.5 seconds in length. The most recent occurrence of the class is centered.

The lead, the frequency, and the time and date of the last occurrence appear to the right of each presentation.

*Figure 10-1: Arrhythmia waveforms*
Arrhythmia

Enabling and Adjusting Alarms

In addition to the ECG alarms described in Enabling and Adjusting Alarms on page 9-15, the Multiview I or II options provide alarms for Abnormals-in-a-Row and Abnormals-per-Minute. Refer to Setting Alarm Limits on page 6-7 for details on operating system alarms.

<table>
<thead>
<tr>
<th>To set or adjust alarms for abnormal beats (arrhythmia detection must be enabled):</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch ECG.</td>
</tr>
<tr>
<td>• Touch ALARM LIMITS.</td>
</tr>
<tr>
<td>• Touch ALARMS / ON.</td>
</tr>
<tr>
<td>• Select ABN IN ROW = or ABN PER MIN =.</td>
</tr>
<tr>
<td>• Use the arrow keys to adjust.</td>
</tr>
</tbody>
</table>

Note:
If the alarm limits for high rate, low rate, ABN PER MIN, or ABN IN ROW appear as reverse video, it indicates that the Alarm Tone and Alarm Recording features are disabled for the indicated alarm.

Abnormals-in-a-Row and Abnormals-per-Minute Alarms

Following the learn sequence, the Abnormals-in-a-Row alarm limit and the Abnormals-per-Minute alarm limit are set. You can adjust or deactivate the alarm limit.

• Setting the Abnormals-in-a-Row alarm limit to three or greater initiates a RUN ALARM message when three or more consecutive abnormal beats (at a rate greater than 90 bpm) occur.
• Setting the Abnormals-in-a-Row alarm limit to two initiates a COUPLE ALARM message when two consecutive abnormal beats occur.

Reviewing Arrhythmias

<table>
<thead>
<tr>
<th>To review arrhythmias:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch ECG.</td>
</tr>
<tr>
<td>• Touch REVIEW.</td>
</tr>
<tr>
<td>• Select an arrhythmia class type for review.</td>
</tr>
<tr>
<td>• Select NEXT CLASS or PRIOR CLASS keys to progress through the review.</td>
</tr>
</tbody>
</table>

Note:
Arrhythmia Review functions are only available in modules with the Multiview II option in the ADULT mode. Arrhythmia detection and Review must be enabled.
### Selecting Arrhythmia Classes

The numeric value for each arrhythmia key indicates the number of occurrences the system has stored. If no occurrences have been detected, the number on the key is 0 and the key is disabled. For classes that only store the last occurrence of that type of arrhythmia (for example, tachycardias of a supraventricular origin), no value is displayed. The menu updates as new classes are created.

### Selecting Leads for Review

When you access the **Arrhythmia Review** menu, the LEAD key indicates which leads were being monitored the last time the displayed event occurred. The lead associated with the currently displayed waveform is highlighted. Touch the LEAD key to display the waveform for the other lead.

### Multiple Arrhythmia Classes

The system assigns numbers to each class to distinguish between classes of the same type with different morphologies. The class number is displayed to the right of the class type (for example, ABNORMAL 1).

The system displays, in sequence, up to 32 different runs and/or pauses. However, the system always keeps the longest run or pause. If the system detects one more pause and/or run than it can store, it replaces the oldest run or pause with the new one (i.e., first in, first out).

### Updating Classes

The system updates the review waveform once each minute for the dominant, paced, and AV-paced classes. Otherwise, it updates it with each occurrence.

### Controlling Arrhythmia Alarms

Touch ALARM YES / NO to enable or disable alarms for couplets, single abnormals, or tachycardia. Disabling alarms for a specific arrhythmia prevents alarm generation for subsequent detection of that arrhythmia class. At least one episode of the class must be stored before the alarm can be disabled. Refer to *Enabling and Adjusting Alarms* on page 10-9 for additional alarms information.

---

**To control arrhythmia alarms:**

- Touch ECG.
- Touch REVIEW.
- Touch ARRHYTHMIA REVIEW.
- Select CPL, ABN or TACH.
- Select ALARM YES or NO.
Clearing a Class or Event

When you clear a class, the system removes it from memory.

- Touch the ENTIRE CLASS key to clear the displayed class and template from memory and from the trend buffer.
- Touch the LAST EVENT key to remove only the most recent occurrence of the displayed class from memory. The LAST EVENT key is only active for abnormal and couplet classes.

To clear a class or the most recent event in a class:
- Touch ECG.
- Touch REVIEW.
- Touch ARRHYTHMIA REVIEW.
- Select an arrhythmia class.
- Touch CLEAR.
- Select ENTIRE CLASS or LAST EVENT.

When you clear the most recent event:
- The most recent occurrence of that class is removed from memory.
- The message *THE LAST OCCURRENCE OF THIS CLASS WAS DELETED* appears in place of the cleared waveform.
- The totals for frequency and last occurrence are updated. The updated information does not appear until you re-display the class.

Merging Classes or Trends

Merging enables you to take two different classes or trends from the same group and merge them together into a single class. This combines the trend history and time of last occurrence.

To merge class or trend data:
- Touch ECG.
- Touch REVIEW.
- Touch ARRHYTHMIA REVIEW.
- Select an arrhythmia class.
- Touch MERGE.
- Use PRIOR CLASS or NEXT CLASS to display the two classes you wish to merge.
- Select MERGE CLASSES or MERGE TRENDS.

To combine the data for two recurring arrhythmia classes, merge the classes instead of the trends. Merging classes permits the two classes to be stored and trended together on an ongoing basis.
Arrhythmia

To combine an active arrhythmia class with an inactive class, merge the trends. An example of an inactive arrhythmia class is the dominant morphology associated with a previous lead selection.

Merging Classes

When a single morphology is frequently being stored as two different classes, merging the classes makes more disk space available for new classes and saves all arrhythmia data. This can occur if a patient's dominant beat is experiencing frequent changes in polarity or when the electrodes have been repositioned.

At the beginning of merging two classes, one class appears on the left side of the display and the second class appears on the right side. The message MERGE THESE CLASSES OR SELECT ANOTHER CLASS appears at the bottom of the display.

Two classes can be merged by touching the MERGE CLASSES key. After merging, the first beat appears as a template on the left side of the display. The label (M1) follows the class title. Any subsequent beat that fits any of the merged templates is then stored in that class.

You can merge a maximum of two classes into a third class.

The following constraints apply to merging classes:

- Two individual templates can be merged into a class with its own existing template.
- One class of two (previously merged) templates can be merged with one additional template.

If a class has been merged once, then (M1) follows the class number, for example, ABNORMAL 12 (M1).

If a class has been merged twice, then (M2) follows the class number, for example, ABNORMAL 12 (M2).

Merging Trends

There is no limit to the number of trends that you can merge. Merging trends of arrhythmia data deletes the template for the class that has been merged. If an arrhythmia event occurs that matches the merged class, a new class is created.

Merge Constraints

The following additional constraints apply to merging individual classes or trends:

- Runs and pauses cannot be merged.
- Couplets can only be merged with couplets.
- Single, abnormal classes or trends can be merged with each other or with the dominant, paced, or AV-paced classes/trends.
- If the system cannot merge any of the existing classes or trends, the MERGE key is disabled in menus for those classes or trends.
- Only classes or trends that the system can merge are presented.
Arrhythmia Trend Graphs

An arrhythmia trend graph consists of:

- A 1.5-second segment of the selected class waveform on the left (individual class trends only).
- A trend graph of the selected class, or group of classes, on the right. Refer to Figure 10-2.

When you select CLASS TREND, the trend graph shows occurrences of events that match that particular class. The total number of events that occurred during the time period between the cursors appears below the trend graph.

When you select GROUP TREND, the trend graph shows occurrences of all events in that group of classes along with the average heart rate. For example, the group trend for abnormal classes shows the occurrences of all single, abnormal beats regardless of the class in which they are stored.

- The trend graph for the dominant group displays the total of all abnormal beats, including beats in runs, over the selected timebase.
- A total of all events specific to the selected class over the selected timebase displays for all other trended classes.

Each trend graph is displayed with two scales. These scales are automatically selected based on the heart rate and arrhythmia values.

- The scale on the left represents the heart rate.
- The scale on the right represents the number of arrhythmias detected over the trended period.

To display an arrhythmia trend graph:
- Touch ECG.
- Touch REVIEW.
- Touch ARRHYTHMIA REVIEW.
- Select an arrhythmia class for review.
- Select CLASS TREND or GROUP TREND.
Arrhythmia

Positioning the Cursors

The cursors are small, bright lines that move along the bottom of the trend display. They enable you to view the number of trended events that occurred between any two time points displayed on the trend graph. Initially, the left (L) cursor is located at the left edge of the trend graph, and the right (R) cursor is located at the right edge of the trend graph. The number of trended events between (and including) the cursor points appears below the trend graph. If the cursors move past each other, the L cursor becomes the R cursor and vice versa.

<table>
<thead>
<tr>
<th>To position the cursors on the trend graph:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch CURSOR L or R to highlight either the left or the right portion.</td>
</tr>
<tr>
<td>• Touch the trend graph to position the cursor near the desired point.</td>
</tr>
<tr>
<td>• Use the arrow keys for adjustment of the cursor.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To select a timebase for class or group trends:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Display an arrhythmia trend graph.</td>
</tr>
<tr>
<td>• Select a TIMEBASE (6, 12, or 24 hours).</td>
</tr>
</tbody>
</table>

Selecting a Timebase

You can select the time period for the arrhythmia trend graph. The resolution for each timebase is shown below.

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Timebase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 minute</td>
<td>6-hour trend graph</td>
</tr>
<tr>
<td>2 minutes</td>
<td>12-hour trend graph</td>
</tr>
<tr>
<td>4 minutes</td>
<td>24-hour trend graph</td>
</tr>
</tbody>
</table>

Excluding Classes from Trends

You can exclude specific classes from the group trend for that class and from the dominant trend graph (only valid with CPL and ABN classes). The default setting is INCLUDE / YES, which indicates that all classes will be included. When you select a class, the template for that class appears on the display, followed by a trend graph that shows all of the occurrences of that class over the selected trend graph timebase.

<table>
<thead>
<tr>
<th>To exclude a class in a group trend:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Display an arrhythmia class trend graph.</td>
</tr>
<tr>
<td>• Select INCLUDE / NO.</td>
</tr>
</tbody>
</table>
Arrhythmia

Printing Arrhythmia Data

All printouts of ECG or arrhythmia data are annotated with the following data:

- Bed identification
- Time and date of the printout
- Lead designator

You can print all arrhythmia data for all classes, or individually selected classes. You can also print individually selected arrhythmia data.

Touch PRINT ALL to print all ST events and all arrhythmia classes. PRINT ALL also prints all the leads.

---

**To print recordings of ALL arrhythmia events:**
- Touch ECG.
- Touch PRINT.
- Touch PRINT ALL.
  - OR-
  - Touch ARR CLASSES.

**To print selected arrhythmia classes:**
- Touch ECG.
- Touch REVIEW.
- Touch ARRHYTHMIA REVIEW.
- Select an arrhythmia class.
- Touch PRINT.

**To print selected arrhythmia trends:**
- Touch ECG.
- Touch REVIEW.
- Touch ARRHYTHMIA REVIEW.
- Select an arrhythmia class.
- Select CLASS TREND or GROUP TREND.
- Touch PRINT.
Arrhythmia Problem Solving

Refer to *ECG Problem Solving* on page 9-22 for additional monitoring tips.

**False Alarms**

Careful attention to good monitoring techniques, especially during setup, reduces false alarms.

*When false alarms occur, check for the following:*

- Multiple classes with atrial fibrillation or flutter waveforms. Either 1) merge these classes with the dominant or another abnormal class; 2) deactivate the alarms for these classes; or 3) consider deactivating the Abnormals-per-Minute alarm.
- Noise that may be mis-classified as QRS complexes. Review the morphology of abnormal classes that are triggering alarms. Either merge these abnormal classes together or deactivate the alarm for these classes.
- VFIB that may resemble previously classified abnormal beats. This may cause VFIB to be detected as a RUN. If this occurs, use the waveform display as the primary indication of condition.
- Some beats may not be recognized as being morphologically different from the learned dominant beat. You may be able to improve performance by changing electrode positions or switching to a lead setting that provides better differentiation between the dominant and abnormal beats.

**Abnormal Beats Improperly Classified**

*Several conditions may cause beats to be improperly classified:*

- The message *NOISY SIGNAL* indicates too much noise is present on one or both ECG channels.
- The message *ECG VOLTAGE TOO LOW* indicates that the signal level is below the threshold for QRS detection.
- Some beats are not recognized as being different from the learned dominant beat.

You may be able to improve performance in these cases by changing electrode positions or by switching to a lead setting that provides a better signal or allows abnormal beats to be more clearly differentiated from dominant beats.

**No Couplet or Run Alarms**

*If alarms do not occur as expected, check the following:*

- The Abnormals-in-a-Row alarm limit may be set too high to generate an alarm for couplets. When you wish to be alerted for couplets, set the Abnormals-in-a-Row alarm limit to 2.
- Abnormal beat(s) may not meet the classification criteria of 15% prematurity (for the second beat in a couplet or subsequent beats — at 90 bpm — in a run) and R-R intervals of less than or equal to 666 ms. No action is indicated. An Abnormals-in-a-Row alarm (COUPLET or RUN) will not be generated unless both criteria are met.
- Processing may have been suspended or the signal quality may be poor. Resume processing or check electrodes for other causes of a poor signal.
Arrhythmia

Previous Abnormals Classes Missing in Arrhythmia Review

If you find that previously classified abnormal beats are no longer stored for review, one of the following conditions has occurred:

- The class has been cleared.
- The memory (data) was cleared (purged) using the RELEARN key, or during the Admit/Discharge function.
- A module error recovery reset occurred.

Classes Full

The total number of abnormal and couplet classes that can be stored is 12. When the system detects the 13th class, the message **CLASSES FULL** appears with an alert tone (if the tone is set to ON).

A Classes Full condition can be cleared by:

- Merging one or more classes.
- Merging one or more trends.
- Deleting one or more classes for abnormals or couplets.

Note:

*All alarm events occurring when classes are full will initiate an appropriate alarm.*
# Arrhythmia Troubleshooting Guide

**Caution:**
Status messages indicate a problem or condition which may affect accurate monitoring values. Do not ignore these messages. Correct any fault before continuing.

<table>
<thead>
<tr>
<th>Clinical Situation</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abnormal beat not detected</td>
<td>■ Module receiving inadequate signal; <em>NOISY SIGNAL</em> or <em>ECG VOLTAGE TOO LOW</em> messages appear. Noise level is above allowable range, or signal level is below QRS detection threshold.</td>
<td>■ Make the necessary adjustments to restore a good signal.</td>
</tr>
<tr>
<td></td>
<td>■ Some beats not recognized as morphologically different from the learned dominant beat.</td>
<td>■ Check all leads to determine a better monitoring lead, or select another lead.</td>
</tr>
<tr>
<td></td>
<td>■ System has not detected five abnormal beats or three couplets of similar morphology needed to qualify a class.</td>
<td>■ Remove the cause of the noise.</td>
</tr>
<tr>
<td></td>
<td>■ Arrhythmia detection is not enabled.</td>
<td>■ No action is required. Some events that may be diagnosed as abnormal by a skilled clinician may not meet the module's criteria for abnormality.</td>
</tr>
<tr>
<td>False Alarms</td>
<td><strong>Note:</strong> Careful attention to good monitoring technique, especially setup, keeps false alarms at a low level. If false alarms do occur, check the following.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>■ Noise on the signal caused by poor electrode application is the most common cause of false alarms.</td>
<td>■ Remove the cause of the noise.</td>
</tr>
<tr>
<td></td>
<td>■ Deactivate alarm for classes that fill up with repetitive artifact. Do not clear these classes.</td>
<td></td>
</tr>
</tbody>
</table>
### Arrhythmia

<table>
<thead>
<tr>
<th>Clinical Situation</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>False Alarms (continued)</td>
<td>Multiple abnormals classes with atrial fibrillation or flutter waveforms.</td>
<td>Merge the class with the dominant or another abnormals class.</td>
</tr>
<tr>
<td></td>
<td>Atrial fibrillation continually triggering a TACH alarm.</td>
<td>Consider deactivating TACH alarm.</td>
</tr>
<tr>
<td></td>
<td>Atrial fibrillation continually triggering a TACH alarm.</td>
<td>Consider deactivating TACH alarm.</td>
</tr>
<tr>
<td></td>
<td>Limits set too close to patient's heart rate.</td>
<td>Check and adjust the alarm limits.</td>
</tr>
<tr>
<td></td>
<td>Amplitude of ECG signal has dropped below threshold of R-wave detector.</td>
<td>Reposition electrodes and relearn patient's rhythm.</td>
</tr>
</tbody>
</table>
ST Analysis

Directory of Keys

ECG MENU

ALARM LIMITS

ECG - REVIEW

ST REVIEW

REAL TIME ST TREND

TREND DISPLAY

TREND TIMEBASE

15 min / 30 min

ST REVIEW - ST SEGMENT LEVELS at HR:MIN DAY-MONTH-YEAR

CLEAR

TIME SAVE xx min

ST TREND

PRIOR SET

NEXT SET

SAVE SET

PRINT

TREND OF ST SEGMENT LEVEL

ST SCALE

TIMEBASE 6 HOURS

PRINT

Do you wish to clear the displayed ST data?

YES

NO

ECG - ALARM LIMITS

ALARMS

ON

OFF

HJ = 130

LO = 40

ABN IN ROW = 5

ABN PER MIN = OFF

↑

↓

SINGLE ST = 1.00

MULTI ST = 0.50

ST LEADS

Highlighted leads are included in ST alarms. Touch to include or exclude.

I

II

III

VI

V2

V3

V4

V5

V6

AVF

AVL

AVR
Overview

The ST analysis function monitors changes to the ST segment level. Only a clinical can determine the significance of ST changes.

The accuracy of ST segment measurements may be affected by:

- Wide complex QRSs (for example, bundle branch block)
- Wolff-Parkinson-White (WPW) syndrome
- Fusion beats classified as dominants

The ST segment is composed of frequencies at the lower end of the frequency range (0.05 Hz). The system automatically analyzes the ST segment at 0.05 Hz whether the display mode is set to MONITOR or EXTENDED.

ST segment analysis starts during the ECG learn sequence. Based on the dominant waveform, the PR (isoelectric), J, and ST points are automatically identified for each beat. The amplitude difference between the ST point and the PR point is referred to as the ST segment level.
Display Detail

The current ST segment level is displayed for all leads to the right of the ECG parameter key in both the SPLIT-VIEW and FULL-VIEW modes. Question marks (???) appear when the current ST segment level is not available. OFF appears when the lead is not connected.

Figure 11-1: Full-view display, bedside monitor
**ST Analysis**

**Figure 11-2: Split-view display, bedside monitor**

1. ECG waveform for first lead
2. ECG parameter key
3. Abnormals-per-minute counter *
4. Display resolution (MONITOR or EXTENDED)
5. PACED mode indication (pacemaker detection is enabled)
6. Abnormals-per-minute alarm limit *

**Figure 11-3: Real-time ST trend display**

1. ECG waveform for first lead
2. ECG parameter key
3. Abnormals-per-minute counter *
4. Display resolution (MONITOR or EXTENDED)
5. PACED mode indication (pacemaker detection is enabled)
6. Abnormals-per-minute alarm limit *
ST Analysis

7 Abnormals-in-a-row alarm limit *
8 ECG rate alarm limits
9 QRS indicator (flashes once per detected beat)
10 Current heart rate
11 ST Segment levels for full-view and split-view display
12 ECG full-view display
13 ECG split-view display
14 Real-time ST trend
15 Amplitude scale in millivolts
16 Time scale — either 15 or 30 minutes

* Only appears with the Multiview I or II option in the ADULT mode with Arrhythmia detection enabled.

Setting Up ST Monitoring

ST analysis is performed on all available ECG leads, even if they are not currently displayed. Setup for ST monitoring is the same as for ECG monitoring (refer to ECG Setup on page 9-6).

Note:
ADULT mode ST analysis and review functions are only available in modules with the ST option.

To set up ST monitoring:
- Set up system and patient for standard ECG monitoring.
- Touch ECG.
- Touch SETUP.
- Touch CONFIG.
- Select ADULT.
Enabling and Adjusting Alarms

ST alarms can be activated manually or automatically, typically within 30 to 60 seconds after completion of the learn sequence. You can adjust alarm limits in increments of 0.25 mm, as needed, for both single-lead ST and multiple-lead ST alarm conditions. Refer to Setting Alarm Limits on page 6-7 for details on operating system alarms.

The SINGLE ST alarm enables you to monitor localized changes that may only be detectable in a single lead. An ST alarm for a SINGLE LEAD activates if the ST level for any one lead exceeds the SINGLE ST alarm limit, with respect to its current reference level.

The MULTI ST alarm enables you to monitor global changes that may be detectable in multiple leads. An ST alarm for MULTIPLE LEADS activates if the ST level for three or more leads exceeds the MULTI ST alarm limit, with respect to each lead’s current reference level.

Note:
- Disabling ECG alarms also disables ST alarms.
- The MULTI ST alarm limit cannot be set equal to or above the SINGLE ST alarm limit if both alarms are enabled.

When ST monitoring is initiated, the reference level for all leads is set to 0.00 mm (isoelectric).
- A SINGLE ST alarm activates if any lead has an initial ST level that exceeds the SINGLE ST alarm limit.
- A MULTI ST alarm activates if three or more leads have initial ST levels that exceed the MULTI ST alarm limit.

When a SINGLE or MULTI ST alarm is activated, the reference level for all leads is automatically reset based on each lead’s current ST level. This enables you to track changes in ST levels throughout the patient’s course of treatment.

In Figure 11-4, DELTA denotes the amount of change needed to set off another alarm. The figure shows that when the patient’s ST segment trend line rises and violates the first alarm threshold, a new baseline and a new upper alarm threshold are established (the lower alarm threshold remains unchanged). The patient’s ST level continues to climb. However, it does not reach the new alarm threshold, so a new baseline and upper limit are not set. When the ST level declines, the alarm threshold also declines until the original alarm thresholds are re-established. As the patient’s ST level continues to decline, a new lower alarm threshold is established when an alarm condition occurs.
As a second example, assume the SINGLE ST alarm is set at 1.00 mm.

- The initial ST amplitude for a particular lead is +0.60 mm.
- Based on the initial reference level of 0.00 mm, an alarm will activate if the ST level exceeds +1.00 mm. Therefore, no alarm occurs.
- The ST level increases immediately to +1.20 mm.
- A SINGLE ST alarm occurs and the new reference level for the lead is set to +1.20 mm.
- The next ST alarm for that lead, assuming no changes are made in other leads, will activate at +2.20 mm.

**Selecting Leads for ST Alarms**

Touch the ST LEADS key to select which leads are to be used to generate ST alarms. You can disable leads that are not clinically relevant for a patient to allow tighter limits to be placed on more clinically significant leads. All highlighted leads are used to generate ST alarms.

---

**To select or deselect leads for ST alarms:**

- Touch ECG.
- Touch ALARM LIMITS.
- Touch ST LEADS.
- Select or deselect leads.
ST Analysis

Reviewing ST Data

Use the **ST Review** menu to display and review ST segment data. A snapshot of ST segments for all available leads displays. The time and date of the snapshot is displayed on the menu prompt line. Touch the PRIOR SET or NEXT SET key to display ST data at other time points. *Figure 11-5* shows an example of an ST segment snapshot.

### To review ST data:

- Touch ECG.
- Touch REVIEW.
- Touch ST REVIEW.

---

<table>
<thead>
<tr>
<th>Lead</th>
<th>Vector</th>
<th>Amplitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>0.16 mm</td>
<td></td>
</tr>
<tr>
<td>AVR</td>
<td>0.16 mm</td>
<td></td>
</tr>
<tr>
<td>V1</td>
<td>0.16 mm</td>
<td>-0.16 mm</td>
</tr>
<tr>
<td>II</td>
<td>0.00 mm</td>
<td></td>
</tr>
<tr>
<td>AVL</td>
<td>0.24 mm</td>
<td></td>
</tr>
<tr>
<td>V2</td>
<td>2.88 mm</td>
<td>-5.70 mm</td>
</tr>
<tr>
<td>III</td>
<td>1.44 mm</td>
<td></td>
</tr>
<tr>
<td>AVF</td>
<td>0.16 mm</td>
<td></td>
</tr>
<tr>
<td>V3</td>
<td>4.32 mm</td>
<td></td>
</tr>
<tr>
<td>V4</td>
<td>0.16 mm</td>
<td></td>
</tr>
<tr>
<td>V5</td>
<td>0.24 mm</td>
<td></td>
</tr>
<tr>
<td>V6</td>
<td>-0.16 mm</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 11-5: ST segment display*

You can store up to nine snapshots. The oldest snapshot not marked as SAVED is deleted to make room to store a new snapshot. To save a snapshot, touch the SAVE SET key.

Snapshots are automatically stored when an ST alarm occurs or at pre-selected time intervals. To store the snapshots at periodic intervals, select TIME SAVE / YES. You can set the interval in the Module Configuration Manager.
Clearing ST Data

Touch the CLEAR key and then confirm your choice by selecting YES to clear the currently displayed data for all leads from memory. Data is also cleared from the trends.

To clear the displayed ST data:
- Touch ECG.
- Touch REVIEW.
- Touch ST REVIEW.
- Touch CLEAR.
- Select YES.

Viewing ST Trends

Trends showing deviations in ST segment level are displayed for each lead monitored in the previous 24 hours (refer to Figure 11-6). Touching the trend graph or one of the arrow keys in the menu displays a cursor on the baseline of the trend graph. Position this cursor at a point of interest in the trend to determine the ST segment level for all displayed leads at that time. A measurement for each lead displays in the table to the right of the trend graph.

To view ST trends:
- Touch ECG.
- Touch REVIEW.
- Touch ST REVIEW.
- Touch ST TREND.
- Touch the trend graph near the desired data point. Then use the arrow keys to adjust the cursor position.
ST Analysis

Selecting the ST Trend Timebase

You can set the timebase for the ST trend graphs to 1.5, 3, 6, 12, or 24 hours. The displayed resolution for each timebase is as follows.

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Timebase</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 seconds</td>
<td>1.5 hours</td>
</tr>
<tr>
<td>1 minute</td>
<td>3 hours</td>
</tr>
<tr>
<td>2 minutes</td>
<td>6 hours (default)</td>
</tr>
<tr>
<td>4 minutes</td>
<td>12 hours</td>
</tr>
<tr>
<td>8 minutes</td>
<td>24 hours</td>
</tr>
</tbody>
</table>

To select a timebase:
- Touch ECG.
- Touch REVIEW.
- Touch ST REVIEW.
- Touch ST TREND.
- Select TIMEBASE of 1.5, 3, 6, 12, or 24 hours.
Printing ST Data

Printouts of ST segment data are annotated with the following:

• Bed identification
• Time and date of the printout
• Lead designator

You can print ST segment waveforms from either the Print or ST Review menu:

• To print all the available ST segment waveforms, use the **ECG Print** menu.
• To print only selected ST segment waveforms or ST trends, use the **ST Review** menu.

**Note:**

*ST segment data cannot be printed using the 90449 printer module.*

---

<table>
<thead>
<tr>
<th>To print all ST segment data:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch ECG.</td>
</tr>
<tr>
<td>• Touch PRINT.</td>
</tr>
<tr>
<td>• Touch ST SEGMENTS.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To print selected ST segments:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch ECG.</td>
</tr>
<tr>
<td>• Touch REVIEW.</td>
</tr>
<tr>
<td>• Touch ST REVIEW.</td>
</tr>
<tr>
<td>• Touch PRINT.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To print the current trend data:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch ECG.</td>
</tr>
<tr>
<td>• Touch REVIEW.</td>
</tr>
<tr>
<td>• Touch ST REVIEW.</td>
</tr>
<tr>
<td>• Touch ST TREND.</td>
</tr>
<tr>
<td>• Touch PRINT.</td>
</tr>
</tbody>
</table>
Displaying Real-Time ST Trends

To facilitate the assessment of short-term changes in ST-segment levels, measurements for a single lead can be displayed as a real-time trend (refer to Figure 11-3). Trend data is continuously updated at three-second intervals. You can select either a 15- or 30-minute time scale for the trend display. The amplitude scale for the trend display adjusts to show the maximum and minimum values for the selected time scale.

To display a real-time ST trend:

- Touch ECG.
- Touch REVIEW.
- Touch REAL TIME ST TREND.
- Select ON.
- Touch TREND TIMEBASE to select 15 or 30 minutes.
### Caution:

Status messages indicate a problem or condition which may affect accurate monitoring values. Do not ignore these messages. Correct any fault before continuing.

<table>
<thead>
<tr>
<th>Clinical Situation</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>No access to ST analysis functions</td>
<td>■ The system must learn the ST segment level before it can provide access to ST analysis functions.</td>
<td>■ Wait until the system analyzes sufficient QRS complexes to calculate the ST segment level (approximately one minute).</td>
</tr>
<tr>
<td>ST = ?? appears</td>
<td>■ Infrequent occurrence of dominant beats.</td>
<td>■ ST analysis is not performed on paced, premature dominant, or abnormal beats.</td>
</tr>
<tr>
<td></td>
<td>■ ECG amplitude may be insufficient to detect QRS complexes.</td>
<td>■ Check QRS amplitude.</td>
</tr>
</tbody>
</table>
12-Lead Diagnostics

Directory of Keys

---

Do you wish to clear the displayed ECG report?

YES  NO

---

Only displays if "Send ECG Report" setting in MCM is MANUAL
Overview

Diagnostic electrocardiographic devices obtain conventional ECG signatures that accurately represent both the detailed waveforms in each cardiac cycle and the beat-to-beat variability to determine cardiac rhythm.

The 12-lead report function acquires and displays 12 ECG vectors in the same format as an electrocardiograph.

Prior to analysis, the ECG data are split into two different paths: one to the system’s monitoring functions and the other to its diagnostic functions. The data in the diagnostic path are acquired at a rate of 500 samples per second, as required by U.S. and international standards for diagnostic electrocardiographic devices.

Note:

- *No automated analysis is completely reliable. A physician should review all ECG results.*
- *Special problems exist with pediatric ECGs because of the considerable differences in the signal characteristics of adults and infants and because of the evolution of the ECG patterns from birth to adolescence.*
- *Digital systems produce a noticeable modulating effect from one cycle to the next, particularly in pediatric ECGs. This is due to the asynchronism between the sample rate for data acquisition and the peak of the QRS waveform.*
Display Detail

The 12-lead report displays 2.5 seconds of waveform data per lead. The leads can be presented in standard format (refer to Figure 12-1) or in Cabrera format. When the analysis is complete, measurements and diagnostic statements may appear above the waveform data.

```
Vent. rate: 60 BPM          SINUS BRADYCARDIA
PR interval: 162 ms         NORMAL ECG
QRS duration: 88 ms
QT/QTc: 360/360 ms
P-QRS-T axes: 50 44 51
```

Figure 12-1: 12-lead report display

1 Measurement and interpretation data (requires the Diagnostic Interpretation feature — Option D)
2 ECG waveforms for 12 leads (2.5 seconds/lead)

Acquiring and Printing 12-Lead Reports

Note:

ECG processing and the pacemaker detection function are suspended for 10 seconds during acquisition of a 12-lead ECG report. This enables the actual pacemaker pulse to appear in the 12-lead report without interfering with arrhythmia analysis.

Twelve-lead reports can be acquired manually (a stat report) or automatically on a scheduled basis. (Initiating a stat report does not affect acquisition of previously scheduled reports.) Any displayed report can be printed by touching the PRINT key.

Because 12-lead reports cannot be acquired if any lead is disconnected, check all electrode connections regularly after the patient is connected to the system. If a lead is disconnected, scheduled reports are skipped and the STAT REPORT key is disabled.
A 12-lead report can only be printed using an ICS printer.
• A PrintMaster (with software version 1.10.04 or greater) is required for the STAT REPORT feature.

To acquire and print a 12-lead ECG report:
• Touch ECG.
• Touch REVIEW.
• Touch REPORT REVIEW.

Manual acquisition:
• Touch STAT REPORT.
• Touch PRINT.

Automatic acquisition at pre-selected intervals:
• Touch REPORT SETUP.
• Select AUTO REPORT of 30 minutes, 1 hour, 2 hours, 4 hours, 8 hours, or 24 hours.
• Touch AUTO PRINT / ON.

Saving and Clearing 12-Lead Reports

Several 12-lead reports can be stored in the system's hard disk. (The exact number depends on the ECG waveforms' signal quality, the frequency, and the complexity of the arrhythmias.) When the disk space is full, the oldest report that is not saved is replaced by the newest report.

You can save a report indefinitely by touching the SAVE key while the report is displayed. You can delete a report from the hard disk by touching the CLEAR key (then confirm your choice by touching YES) while the report is displayed.
To save or clear a 12-lead ECG report:

- Touch ECG.
- Touch REVIEW.
- Touch REPORT REVIEW.
- Touch DIR.
- Select the desired report.
- Use the arrow keys to select the desired report.
- Touch DISPLAY.
- Touch SAVE to save the report.
  - OR-
  - Touch CLEAR and then touch YES to confirm.

**Note:**
Clear the 12-lead report(s) from memory before proceeding to the next patient’s bedside monitor if:

- Your monitoring system is interfaced to an ECG Management System, and
- You are using a single module to acquire 12-lead reports at multiple bedside monitors.

**Sending 12-Lead ECG Reports**

An ECG management system can acquire 12-lead ECG reports from the monitoring system either automatically (as they are acquired) or manually (when you send them). This depends on how your module is configured using the Module Configuration Manager feature.

- If the Send ECG Report feature is set to Automatic, all reports are automatically sent to the ECG management system and the SEND ECG key is not displayed.
- If the Send ECG Report feature is set to Manual, the SEND ECG key is displayed. Touch SEND ECG to send the displayed report to the ECG management system.

**To manually send 12-lead ECG reports:**

- Touch ECG.
- Touch REVIEW.
- Touch REPORT REVIEW.
- Touch DIR.
- Use the arrow keys to select the desired report.
- Touch DISPLAY.
- Touch SEND ECG.
Viewing the Report Directory

Touch the DIR key to display a directory of 12-lead reports. Each report’s time and date and its summary diagnosis (if the Diagnostic Interpretation feature is enabled) appear as a table. Saved reports are marked as YES in the SAVED column (refer to Figure 12-2). Use the arrow keys to select the desired report, and then touch the DISPLAY key to display the selected diagnostic report.

To view directory of 12-lead ECG reports:

- Touch ECG.
- Touch REVIEW.
- Touch REPORT REVIEW.
- Touch DIR.
- Use the arrow keys to select the desired report.
- Touch DISPLAY.

<table>
<thead>
<tr>
<th>TIME</th>
<th>DATE</th>
<th>SAVED</th>
<th>DIAGNOSIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:00</td>
<td>28 OCT</td>
<td>YES</td>
<td>ABNORMAL ECG</td>
</tr>
<tr>
<td>1:30</td>
<td>28 OCT</td>
<td></td>
<td>NORMAL ECG</td>
</tr>
<tr>
<td>2:00</td>
<td>28 OCT</td>
<td></td>
<td>NORMAL ECG</td>
</tr>
<tr>
<td>2:30</td>
<td>28 OCT</td>
<td></td>
<td>NORMAL ECG</td>
</tr>
<tr>
<td>3:00</td>
<td>28 OCT</td>
<td>YES</td>
<td>ABNORMAL ECG</td>
</tr>
<tr>
<td>3:30</td>
<td>28 OCT</td>
<td>YES</td>
<td>NORMAL ECG</td>
</tr>
</tbody>
</table>

Figure 12-2: Report directory
Entering Patient Demographics

The diagnostic ECG algorithm requires the patient’s gender, date of birth, height, and weight. You must enter the patient’s demographics correctly to obtain an accurate diagnosis. This information is entered through the Admit function (refer to Admit/Discharge on page 7-3). If patient demographic information is not entered, the diagnostic ECG algorithm uses the following defaults:

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of Birth</td>
<td>40 years</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
</tr>
<tr>
<td>Height</td>
<td>5 feet 10 inches</td>
</tr>
<tr>
<td>Weight</td>
<td>180 pounds</td>
</tr>
</tbody>
</table>
Cardiac Output

Directory of Keys

- CO
- CO MENU
- CARDIAC OUTPUT
- HEIGHT/WEIGHT
- CALCS
- CC = .550

Enter Computational Constant

BSA = ? Must enter patient height and weight for calculations

Inject when ready

CO #1

BAD CURVE

CO #2

CO #3

CO #4

Inject when ready

TB XX.X ° C
TI X.X ° C

STOP CURVE

AVERAGE

ALL

CLEAR

CANCEL

STORE

CALCS

PRINT

AUTO

MANUAL

START

CO

CO/CI

Refer to page 13-2

Press YES to confirm STORE

YES

NO

Press YES to confirm CLEAR

YES

NO

Press YES to confirm AVERAGE ALL

YES

NO
Cardiac Output

Calculations

VITAL SIGNS - Adjust vital signs, then touch ENTER

Select a row of data by pressing the key corresponding to the day/time desired
Cardiac Output

Overview

Cardiac output (CO) monitoring enables you to evaluate the patient's fluid status and the pumping ability of the heart. It also calculates and displays various hemodynamic values. Cardiac output is calculated by the thermodilution technique, using a variation of the Stewart-Hamilton formula. Thermodilution involves injecting a cooled or room temperature fluid (injectate) through a flow-through housing and into an intravascular catheter. The catheter delivers the injectate directly to the right atrium. It monitors the temperature downstream from the delivery site at the pulmonary artery.

Cardiac output is determined by measuring the change in blood temperature downstream from the delivery site with respect to time. The change in temperature is inversely proportional to the flow of blood through the right heart. If the flow is large, the volume of blood that the injectate mixes with is also large, so the monitor detects a small change in temperature. When a smaller flow of blood is diluted by the same volume of injectate (as in the pulmonary artery), the change in temperature is larger.

The system displays cardiac output by acquiring a curve for each injection. The vertical axis of the curve represents temperature, and the horizontal axis represents time.

Vital sign values are automatically captured at the moment each CO curve is completed. This information is used to produce hemodynamic calculations.
Setting Up Cardiac Output Monitoring

The following setup procedure assumes that the pulmonary artery catheter has been properly placed in the patient. *Figure 13-1* illustrates the components used for CO monitoring.

*Figure 13-1: Cardiac output monitoring setup*

1. Thermistor connector
2. Thermodilution catheter
3. Module connection
4. Injectate
5. Cardiac output cable
6. In-line injectate temperature probe
Cardiac Output

To set up cardiac output monitoring:
- Insert the cardiac output cable into the module.
- Attach the thermodilution catheter to the cardiac output cable.
- Connect either an in-line injectate temperature probe or a reference solution injectate probe to the cardiac output cable.

When using a reference solution injectate temperature probe, it should be inserted into the cardiac output cable in place of the in-line injectate temperature probe.

Display Detail

The CO key appears once you connect the cardiac output cable to the module. To display the CO menu, touch the CO key.

When you connect the thermistor connector port of the catheter to the cardiac output cable, the patient’s blood temperature (TB) value displays. When you connect the injectate temperature probe, the temperature of the injectate (TI) displays, but the information is not trended. A message appears, instructing you to connect the probe or catheter or to enter the computational constant (CC).

If you connect the cardiac output cable only to the catheter or only to the injectate probe, you can enter or adjust the computational constant, but you cannot monitor cardiac output.

The message Touch START then inject appears if you select MANUAL mode. The message Inject when ready appears when the system is ready to acquire a new output curve (if AUTO mode is selected. Curves appear as the system detects the flow for each injection. Five curves can be displayed at one time. Figure 13-2 illustrates the cardiac output display on a bedside monitor when curves are being acquired.

Figure 13-2: Bedside monitor
Cardiac Output

1. Cardiac output curve
2. Curve ID number key (used to select a curve) (ranges from 1 to 99)
3. Cardiac output value (liters/minute)
4. STOP CURVE key (only appears during curve drawing)
5. Cardiac index value (average) (only appears if CI was calculated when CO was acquired)
6. Time and date of averaging
7. Cardiac output value (average)
8. Injectate temperature
9. Blood temperature
10. Cardiac index value

Displaying Cardiac Output and Cardiac Index Values

The cardiac output value, or both cardiac output and cardiac index values, can be displayed with the curves. If the CO portion of the CO / CO/CI key is selected, only the cardiac output value appears. To display both the cardiac output and cardiac index values, select the CO/CI segment of the key.

To display both cardiac output and cardiac index values with the curves:

- Touch CO.
- Touch CARDIAC OUTPUT.
- Touch CO / CO/CI.

Entering the Computational Constant

To acquire cardiac output data, you must first enter the computational constant (CC) and verify that the system is correctly configured.

The injectate temperature changes because of contact with the catheter wall and the surrounding blood. To account for this interaction, the system includes a correction factor in the equation. The correction factor (K or CT) is a function of the catheter and the dimensions of the flow-through housing, internal volume, and injectate temperature. The correction factor differs among catheter models and manufacturers. Refer to your thermodilution catheter package insert for the CC value.

Once you enter a value for the computational constant, the value appears on the CC= key and remains in the system's memory. The message CC REQUIRED appears until you enter the computational constant.
Cardiac Output

To enter the computational constant:

- Touch CO.
- Touch CC=.
- Touch the appropriate keys (tenths, hundredths, and then thousandths) and use the arrow keys to adjust.
- Touch ENTER.

Entering Patient Height/Weight

To perform indexed hemodynamic calculations, you must enter the patient's height and weight before you generate CO curves. CO uses the patient's height and weight entered during admission (refer to Entering Height, Weight, and Body Surface Area (BSA) on page 7-6). The valid range for height is from 8 to 84 inches (20 to 215 cm). The valid range for weight is from 2 to 551 pounds (1 to 250 kg). After you enter both height and weight values, the system automatically calculates and displays the patient's body surface area (BSA).

To enter patient height and weight:

- Touch CO.
- Touch HEIGHT/WEIGHT.
- Select HEIGHT = or WEIGHT =.
- Use the arrow keys to adjust.
- Touch ENTER.

Measuring Cardiac Output

Allow the catheter to warm up between injections to maintain the accuracy of the readings. Once the blood temperature is stable, the INJECT WHEN READY message appears (AUTO mode) or the TOUCH START THEN INJECT message appears (MANUAL mode).

The STOP CURVE key that appears during data acquisition enables you to stop acquiring and drawing the cardiac output curve. Touching this key invalidates all curve data for that injection.
Some curves may automatically be classified as “bad,” in which case they are labeled BAD CURVE.

**There are a number of possible causes for bad curves:**
- Unsteady baseline
- Irregular curve from shunts or poor injection
- Delayed curve
- Catheter or probe fault during curve acquisition

If a bad curve is displayed when you select to average, store, or clear another displayed curve, the bad curve is also cleared. Delete bad curves as necessary to acquire additional curves.

**Note:**

To obtain all hemodynamic calculations, remember to enter height and weight, and to store a PCWP prior to initiating a measurement of CO.

A 15-minute timer begins after acquisition of the first good curve. After 15 minutes, the AUTO/MANUAL and START keys become unavailable, and the message **MUST SELECT CURVES, AVERAGE, STORE, or CLEAR CO** appear. Cardiac output injections are disabled until you perform one of these actions. Injections may resume as soon as the **INJECT WHEN READY** or **TOUCH START THEN INJECT** message appears.

### Averaging Cardiac Output

This function computes the average using the data from up to five good, displayed curves. Curves labeled as bad curves are not included in the average. You can perform cardiac output averaging as soon as the system has measured and displayed at least two good curves.

**When the averaging is complete, the CO zone displays the following:**
- Curves used in the average
- Averaged cardiac output and cardiac index values
- Time and date of the last curve
Clearing and Storing Cardiac Output Curves

Occasionally you may want to delete a curve prior to averaging or storing. All curves, or only selected curves, can be cleared. When you clear an individual CO curve or all CO curves, the Inject when ready message appears in the first available curve position, so the curves displayed on the display may not appear in numerical order.

The Store feature enables you to store all acceptable, displayed curves at once or individually. The system stores the vital signs and cardiac output values acquired at the end of curve acquisition, along with the time it displayed each curve. The curves clear from the display as they are stored. After you store the acceptable curves, the system clears all curves from the display.

To average all cardiac output curves:

- Touch CO.
- Touch CARDIAC OUTPUT.
- Touch AVERAGE ALL.
- Touch YES.

To clear or store selected curves:

- Touch CO.
- Touch CARDIAC OUTPUT.
- Touch the CO# key(s) adjacent to the curve(s) (up to five) that you wish to clear or store.
- Select CLEAR or STORE.
- Touch YES.

To clear or store all curves:

- Touch CO.
- Touch CARDIAC OUTPUT.
- Select CLEAR or STORE.
- Touch YES.
# Cardiac Output

## Calculations Table

You can view the hemodynamic calculations table after storing or averaging data. The table includes only those calculations that have been stored or averaged.

The system uses the BSA to normalize the values. Cardiac Index (CI) and Stroke Volume Index (SVI) values are automatically displayed. You can choose to display either the Systemic Vascular Resistance (SVR) and Pulmonary Vascular Resistance (PVR) values, or their indexed values (SVRI and PVRI), but not both simultaneously. You can also choose to display either the Left Ventricular Stroke Work (LVSW) and Right Ventricular Stroke Work (RVSW) values, or their indexed values (LVSWI and RVSWI), but not both simultaneously.

<table>
<thead>
<tr>
<th>To display the calculations table:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Touch CO.</td>
<td></td>
</tr>
<tr>
<td>Touch CALCS (or touch CARDIAC OUTPUT and then CALCS).</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To select indexing:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Touch CO.</td>
<td></td>
</tr>
<tr>
<td>Touch CALCS (or touch CARDIAC OUTPUT and then CALCS).</td>
<td></td>
</tr>
<tr>
<td>Select VR INDEX / ON or SW INDEX / ON.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To view additional sets of data:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Touch CO.</td>
<td></td>
</tr>
<tr>
<td>Touch CALCS (or touch CARDIAC OUTPUT and then CALCS).</td>
<td></td>
</tr>
<tr>
<td>Touch SCROLL UP to scroll the data up one row, touch SCROLL DOWN to scroll the data down one row.</td>
<td></td>
</tr>
</tbody>
</table>

*Table 1 shows an example of the hemodynamic calculations table that appears when you touch the CALCS key. Each row is one complete set of data. Each new value appears in a new row at the bottom of the table. Five sets of data are displayed at any one time. Additional sets of values can be displayed by scrolling through the data. Thirty sets of values are saved in the monitor's hemodynamic calculations table, so you can remove and re-insert the module without losing hemodynamic values. You can erase these values by discharging a patient or by powering the monitor OFF.*

*Note:*

*The vital sign values shown in Table 1 are typical if your monitor's UNITS OF MEASURE key is set to mmHg.*
Cardiac Output

Table 1: Sample Hemodynamic Calculations Table

<table>
<thead>
<tr>
<th>DAY/TIME</th>
<th>CO</th>
<th>CI</th>
<th>SV</th>
<th>SVI</th>
<th>SVR</th>
<th>PVR</th>
<th>LVSW</th>
<th>RVSW</th>
<th>HR</th>
<th>MAP</th>
<th>CVP</th>
<th>MPA</th>
<th>PCWP</th>
</tr>
</thead>
<tbody>
<tr>
<td>26/02:25p</td>
<td>5.1</td>
<td>2.9</td>
<td>70.8</td>
<td>40.4</td>
<td>1629</td>
<td>235</td>
<td>54.9</td>
<td>10.4</td>
<td>72</td>
<td>110</td>
<td>6</td>
<td>25</td>
<td>10</td>
</tr>
<tr>
<td>26/09:30p</td>
<td>4.9</td>
<td>2.8</td>
<td>65.3</td>
<td>37.8</td>
<td>1712</td>
<td>211</td>
<td>51.4</td>
<td>9.2</td>
<td>75</td>
<td>112</td>
<td>7</td>
<td>25</td>
<td>12</td>
</tr>
<tr>
<td>26/10:15p</td>
<td>4.5</td>
<td>2.5</td>
<td>56.2</td>
<td>32.1</td>
<td>1917</td>
<td>213</td>
<td>44.5</td>
<td>7.8</td>
<td>80</td>
<td>115</td>
<td>7</td>
<td>25</td>
<td>13</td>
</tr>
<tr>
<td>27/07:30a</td>
<td>4.0</td>
<td>2.2</td>
<td>47.0</td>
<td>26.8</td>
<td>2237</td>
<td>219</td>
<td>38.2</td>
<td>6.5</td>
<td>85</td>
<td>120</td>
<td>8</td>
<td>26</td>
<td>15</td>
</tr>
<tr>
<td>27/08:30a</td>
<td>4.0</td>
<td>2.2</td>
<td>47.0</td>
<td>26.8</td>
<td>2237</td>
<td>219</td>
<td>38.2</td>
<td>6.5</td>
<td>85</td>
<td>120</td>
<td>8</td>
<td>26</td>
<td>15</td>
</tr>
</tbody>
</table>

Day/Time Calculated Values Vital Signs Values

The system automatically calculates and enters CO and CI values in the table. Values in the SV, SVI, SVR, PVR, LVSW, and RVSW columns are automatically calculated from the vital sign values displayed in the HR, MAP, CVP, MPA, and PCWP columns.

The values in the HR, MAP, CVP, MPA, and PCWP columns are parameter values obtained from other parameters in the bedside monitor at the time a CO value is calculated, or values that were manually entered (refer to Editing Vital Sign Values on page 13-12).

A CVP value is used in calculations, if it is available. If a CVP value is not available, the RAP value is used in place of CVP. If neither CVP nor RAP pressure is available, the system cannot automatically calculate SVR, SVRI, RVSW, or RVSWI.

Note:

To ensure that a RAP/CVP value can be obtained, immediately reopen the stopcock to the patient after you inject the bolus, so that flow is reinstated.

A PCWP value is used in calculations if the PCWP value was stored within the last 15 minutes. If no such PCWP value is present, an LAP value is substituted. If neither PCWP nor LAP values are available, the system cannot automatically calculate PVR, PVRI, LVSW, or LVSWI, and the message NO PCWP VALUE AVAILABLE WITHIN THE LAST 15 MINUTES appears on the monitor when that curve is acquired.

If you do not enter height and weight values prior to generating CO curves, the monitor displays any value that uses BSA (e.g., CI, SVI, LVSWI, and RVSWI) as ?. If a calculated value is out of the displayable range, the monitor displays the value as +++++. The system uses the value 0 (zero) in the calculations if any of the vital signs in the hemodynamics table are negative.

Table 2 lists the equations used for the hemodynamics table (assumes that pressures are measured in mmHg). Pressure values measured in kPa are automatically converted to mmHg prior to calculation.
### Table 2: Hemodynamic Equations

<table>
<thead>
<tr>
<th></th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSA</td>
<td>(Ht^{0.725} \times Wt^{0.425} \times 0.007184)</td>
</tr>
<tr>
<td>CI</td>
<td>(\frac{CO}{BSA})</td>
</tr>
<tr>
<td>SV</td>
<td>((\frac{CO}{HR}) \times 1000)</td>
</tr>
<tr>
<td>SVI</td>
<td>(\frac{SV}{BSA})</td>
</tr>
<tr>
<td>SVR</td>
<td>(79.9 \times \frac{[\text{MAP}-\text{CVP}]\times \text{CO}}{\text{CO}})</td>
</tr>
<tr>
<td>SVRI</td>
<td>(79.9 \times \frac{\times \frac{[\text{MAP}-\text{CVP}]}{\text{CO} \times \text{BSA}}}{\text{CO}})</td>
</tr>
<tr>
<td>PVR</td>
<td>(79.9 \times \frac{\times \frac{[\text{MPA}-\text{PCWP}]}{\text{CO} \times \text{BSA}}}{\text{CO}})</td>
</tr>
<tr>
<td>PVRI</td>
<td>(79.9 \times \frac{\times \frac{[\text{MPA}-\text{PCWP}]}{\text{CO} \times \text{BSA}}}{\text{CO}})</td>
</tr>
<tr>
<td>LVSW</td>
<td>(0.0136 \times SV \times (\text{MAP} - \text{PCWP}))</td>
</tr>
<tr>
<td>RVSW</td>
<td>(0.0136 \times SV \times (\text{MPA} - \text{CVP}))</td>
</tr>
<tr>
<td>LVSWI</td>
<td>(\frac{LVSW}{BSA})</td>
</tr>
<tr>
<td>RVSWI</td>
<td>(\frac{RVSW}{BSA})</td>
</tr>
</tbody>
</table>

### Editing Vital Sign Values

To edit vital sign values:
- Touch CO.
- Touch CALCS (or touch CARDIAC OUTPUT and then CALCS).
- Touch DAY/TIME in the row you wish to select.
- Touch VITAL SIGNS.
- Select the vital sign you wish to edit.
- Use the arrow keys to edit the displayed value.
- Touch ENTER.
Cardiac Output

Table 3: Hemodynamic and Vital Sign Values

<table>
<thead>
<tr>
<th>Label</th>
<th>Name</th>
<th>Units</th>
<th>Default Value</th>
<th>Valid Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR</td>
<td>Heart Rate</td>
<td>bpm</td>
<td>70</td>
<td>0 to 300</td>
</tr>
<tr>
<td>MAP</td>
<td>Mean Arterial Pressure</td>
<td>mmHg kPa</td>
<td>80 10.7</td>
<td>0 to 300 0 to 40</td>
</tr>
<tr>
<td>CVP</td>
<td>Central Venous Pressure</td>
<td>mmHg kPa</td>
<td>10 1.3</td>
<td>0 to 99 0 to 13.2</td>
</tr>
<tr>
<td>MPA</td>
<td>Mean Pulmonary Artery Pressure</td>
<td>mmHg kPa</td>
<td>15 2</td>
<td>0 to 99 0 to 13.2</td>
</tr>
<tr>
<td>PCWP</td>
<td>Pulmonary Capillary Wedge Pressure</td>
<td>mmHg kPa</td>
<td>10 1.3</td>
<td>0 to 99 0 to 13.2</td>
</tr>
</tbody>
</table>

Default values are supplied if you touch the VITAL SIGNS key and no prior value is available. When you edit a value, the system recalculates the hemodynamic calculation values using the new vital sign value.
Printing Cardiac Output Curves

You can print cardiac output data in the following formats:

- All curves in the CO display area
- The portion of the displayed calculations table

To print thermodilution curves:
- Touch CO.
- Touch CARDIAC OUTPUT.
- Touch PRINT.

To print the CO table:
- Touch CO.
- Touch CALCS (or touch CARDIAC OUTPUT and then CALCS).
- Touch PRINT.

Cables and Probes

Refer to the Spacelabs Healthcare Supplies Products catalog for part numbers and specifications for cables, probes, and injectate systems.

Computational Constants/Catheter Compatibility

Nominal resistance @ 37° C  14,004 Ω ±15%

Refer to the instructions provided with your catheter for the computational constants for your specific catheter, setup, injectate temperature, and injectate volume. Contact your thermodilution catheter sales representative for additional information.

Warning:

For 3 cc injectate volumes, a 0° to 5° C injectate temperature is required for consistent results.

Note:

The cardiac output function is compatible with the Baxter Edwards Critical-Care REF and REF-Ox catheters for cardiac output measurement, but cannot perform the REF function.
# Cardiac Output Troubleshooting Guide

<table>
<thead>
<tr>
<th>Clinical Situation</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unable to acquire CO data</td>
<td>■ There is a problem with the thermodilution catheter (<strong>CATHETER FAULT</strong> message appears).</td>
<td>■ Connect or replace the catheter.</td>
</tr>
<tr>
<td></td>
<td>■ There is a problem with the probe (<strong>PROBE FAULT</strong> message appears).</td>
<td>■ Connect or replace the probe.</td>
</tr>
<tr>
<td></td>
<td>■ Computational constant not entered.</td>
<td>■ Enter computational constant.</td>
</tr>
<tr>
<td>Invalid pressure reading</td>
<td>■ Stopcock of the CVP or RAP line may not have been turned OFF quickly enough after injection was made.</td>
<td>■ Turn the stopcock off immediately after making the injection to provide the module with the correct pressure value at the time it obtains the curve.</td>
</tr>
<tr>
<td>Erroneous CO values using room temperature injectate</td>
<td>■ Injectate is too warm (above 25.5° C) — <strong>TI TOO WARM</strong> message appears.</td>
<td>■ Lower the injectate temperature.</td>
</tr>
<tr>
<td></td>
<td>■ Injection rate is too slow.</td>
<td>■ Administer bolus smoothly at a rate of ≤10 cc/4 seconds.</td>
</tr>
<tr>
<td>Unable to obtain indexed values for calcs</td>
<td>■ Did not enter height and/or weight prior to averaging curves.</td>
<td>■ Enter the height/weight and reinject the curves.</td>
</tr>
<tr>
<td></td>
<td>■ Enter the height/weight in hemo calcs to obtain index values for previously acquired curves.</td>
<td>■ Check vital sign and height/weight values for validity.</td>
</tr>
<tr>
<td>Value of calcs variable displays as +++</td>
<td>■ Measured value is out of range.</td>
<td>■ Check vital sign and height/weight values for validity.</td>
</tr>
<tr>
<td>Clinical Situation</td>
<td>Possible Cause</td>
<td>Solution</td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Spontaneous CO curves drawn while in AUTO mode</td>
<td>Infusion of IV drips or medications through the proximal port.</td>
<td>Turn off the IV solutions temporarily.</td>
</tr>
<tr>
<td></td>
<td>Mechanically ventilated patient is causing shifts in PA temperature.</td>
<td>Use the MANUAL mode.</td>
</tr>
<tr>
<td></td>
<td>Cardiac arrhythmias are causing blood flow variance.</td>
<td>Use the MANUAL mode and time the injection during stable ECG rhythm.</td>
</tr>
<tr>
<td>Substantial variance in CO values/irregular curves</td>
<td>Varied temperature in the bolus.</td>
<td>Standardize the temperature of the bolus.</td>
</tr>
<tr>
<td></td>
<td>Injection is being delivered at varying points in the respiratory cycle.</td>
<td>Use the MANUAL mode and time the injection at end-expiration, if desired.</td>
</tr>
<tr>
<td></td>
<td>Blood temperature is unacceptable <em>(TB OUT OF RANGE message appears).</em></td>
<td>The temperature must be between 27° and 43° C.</td>
</tr>
<tr>
<td></td>
<td>The temperature difference between the injectate and body is less than 8° C <em>(TEMPERATURE ERROR message appears).</em></td>
<td>Lower the injectate temperature.</td>
</tr>
<tr>
<td></td>
<td>Movement.</td>
<td>Standardize the patient position during procedure.</td>
</tr>
<tr>
<td></td>
<td>Physiological problems.</td>
<td>Any of the following conditions can affect accurate readings: ventricular arrhythmias, low stroke volume, and/or valve insufficiency.</td>
</tr>
<tr>
<td></td>
<td>Injectate rate is too slow.</td>
<td>Administer the bolus smoothly at a consistent rate.</td>
</tr>
<tr>
<td>No curve drawn after bolus injected</td>
<td>Insufficient time has elapsed between injections to allow blood temperature stabilization.</td>
<td>Wait 60 to 90 seconds between injections.</td>
</tr>
</tbody>
</table>
Pressure

Directory of Keys

The pressure label you select will appear here

PRESSURE MAIN MENU

ALARM LIMITS  SIZE  SETUP  SELECT LABEL  SCALES  ZERO

Refer to page 14-2  Refer to page 14-2

PRESSURE - SETUP

SWEEP SPEED  FILTER  ART REJ  NUMERIC SIZE

25 mm/sec. 12 Hz  ON  OFF  SIZE

PRESSURE - ALARM LIMITS

ALARMS  SYS  SYS  DIA  DIA  MEAN  MEAN  ALL

ON  HI = 150  LO = 90  HI = 150  LO = 90

OFF  HI = OFF  LO = OFF

Not displayed for pressure labels that do not calculate these values.

PRESSURE - SWEEP SPEED

50 25 12.5 6.25  SAME AS ECG

mm/sec. mm/sec. mm/sec. mm/sec.

PRESSURE - FILTER 12 Hz

↑  ↓

PRESSURE - WAVEFORM SIZE

↑  ↓

PRESSURE - NUMERIC SIZE

SYS/DIA  MEAN  ALL

LARGE  LARGE  LARGE

Not displayed for pressure labels that do not calculate these values.
Labels and Scales

The pressure label you select will appear here

PRESSURE MAIN MENU

ALARM LIMITS  SIZE  SETUP  SELECT LABEL  SCALES  ZERO

Refer to page 14-1  Refer to page 14-1  Refer to page 14-1

PRESSURE - SCALES

SCALE 0-180  SAVE SYS  SAVE DIA  SAVE MEAN  ↑  ↓  ZERO

Not displayed for pressure labels that do not calculate these values.

This key becomes SAVE PCWP with PA

The cursor defaults to the mid-range of the waveform

This scale is now 0 - 180. Enter the new scale setting: 0

0  1  2  3  4  5  6  7  8  9  ENTER

PRESSURE - LABEL SELECT

ART  PA  CVP  RAP  LAP  ICP  UA  UV  PRS
Overview

A pressure key and waveform automatically display when you connect a pressure transducer to the module. The pressure key and waveform disappear from the display when you disconnect the pressure cable or transducer.

You can relabel the catheter site and/or zero the system any time the key and waveform are displayed. Table 1 lists the available pressure key labels.

<table>
<thead>
<tr>
<th>Pressure Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ART</td>
<td>Arterial pressure</td>
</tr>
<tr>
<td>CVP</td>
<td>Central venous pressure</td>
</tr>
<tr>
<td>ICP</td>
<td>Intracranial pressure</td>
</tr>
<tr>
<td>LAP</td>
<td>Left atrial pressure</td>
</tr>
<tr>
<td>PA</td>
<td>Pulmonary artery pressure</td>
</tr>
<tr>
<td>RAP</td>
<td>Right atrial pressure</td>
</tr>
<tr>
<td>PRS</td>
<td>Generic pressure</td>
</tr>
<tr>
<td>UA</td>
<td>Umbilical artery pressure</td>
</tr>
<tr>
<td>UV</td>
<td>Umbilical vein pressure</td>
</tr>
</tbody>
</table>
Setting Up Pressure Monitoring and Zeroing the Transducer

Connect the cable end of a reusable or disposable transducer to the pressure connector located on the front of the module using a Spacelabs Healthcare pressure cable.

When setting up an invasive pressure system, take care to maintain system sterility and to prevent the introduction of air into the system. Air bubbles are the most common cause of inaccurate pressure readings. The transducer, stopcocks, connectors, and tubing must be completely free of air to ensure maximum performance.

Note:
- Refer to the catheter, tubing, or transducer manufacturer’s instructions or your hospital’s protocol for specific instructions on removing air from the system.
- Invasive pressure systems specified by Spacelabs Healthcare are compatible with high-frequency electrosurgical and defibrillation equipment. No special precautions are required.

If a ZERO REJECTED message appears after you have followed the instructions to zero the pressure transducer, follow the transducer manufacturer's directions to correct this problem before you continue.

You must zero the system before you can begin monitoring. Zeroing has the following purposes:
- Establishes atmospheric pressure as zero.
- Compensates for the hydrostatic effect of fluid in the catheter-tubing system.
Pressure

Display Detail

A pressure display appears once you select a pressure label and zero the transducer. *Figure 14-1* shows an example of the ART and ICP displays. The system identifies the specific pressure type in the parameter key and menu title (PA, CVP, LAP, etc.).

To select a pressure label:
- Touch the pressure key displayed.
- Touch SELECT LABEL.
- Select the desired label.

To zero the pressure transducer:
- Position the stopcock close to the patient (at the phlebostatic axis).
- Touch the desired pressure parameter key.
- Open the stopcock to air and close the stopcock to the patient.
- Touch ZERO.
- Close the stopcock to air and open the stopcock to the patient.
- Begin monitoring after the pressure values appear.

*Figure 14-1: Bedside pressure display*

1. Pressure waveforms
Pressure parameter keys

3 Systolic pressure
4 Mean pressure
5 Systolic pressure alarm limits
6 Diastolic pressure alarm limits
7 Diastolic pressure
8 Cerebral perfusion pressure (CPP)
9 Mean pressure alarm limits
10 Mean pressure

Selecting Numeric Display Size

You can select from three different display formats for pressure numeric data (for ART, PA, PRS, UA, and UV only). Figure 14-2 provides examples of each of the three display formats. In each example, mean pressure is 92, systolic pressure is 133, and diastolic pressure is 70.

![Display formats](image)

Figure 14-2: Display formats

**Note:**
Specific alarm limits are not displayed in the All Large display format.

To change the numeric display size:

- Touch the desired pressure parameter key.
- Touch SETUP.
- Touch NUMERIC SIZE.
- Select a display size.
Enabling and Adjusting Alarms

You can set alarms for each pressure channel independently. You can define systolic, diastolic, and mean value alarm limits for ART, PA, UA, UV, and PRS pressures. The ICP Alarm Limits menu includes a cerebral perfusion pressure key (CPP) to set CPP alarm limits, along with keys for the mean limits. Only the mean value alarm limits can be set for all other pressures. Refer to Setting Alarm Limits on page 6-7 for details on operating system alarms.

<table>
<thead>
<tr>
<th>To set or adjust alarm limits:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch the desired pressure parameter key.</td>
</tr>
<tr>
<td>• Touch ALARM LIMITS.</td>
</tr>
<tr>
<td>• Select desired alarm.</td>
</tr>
<tr>
<td>• Select ALARM ON.</td>
</tr>
<tr>
<td>• Use the arrow keys to adjust.</td>
</tr>
</tbody>
</table>

Adjusting Waveform Size and Sweep Speed

You can increase or decrease the size of the pressure waveform display without affecting the signal gain. The waveform size cannot be adjusted while the scales are displayed. The sweep speed determines the rate at which the pressure waveform moves across the display.

<table>
<thead>
<tr>
<th>To change the waveform size:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch the desired pressure parameter key.</td>
</tr>
<tr>
<td>• Touch SIZE.</td>
</tr>
<tr>
<td>• Select SIZE ↑ or SIZE ↓.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To select a pressure waveform sweep speed:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch the desired pressure parameter key.</td>
</tr>
<tr>
<td>• Touch SETUP.</td>
</tr>
<tr>
<td>• Touch SWEEP SPEED.</td>
</tr>
<tr>
<td>• Select a sweep speed or touch SAME AS ECG.</td>
</tr>
</tbody>
</table>
Displaying Waveforms with Scales

You can superimpose a vertical reference scale over pressure waveforms. Up to four pressures can be scaled at one time.

Touch a parameter key and then the SCALES key to display scales when the pressure parameter key is activated. Select SCALES / ON to maintain the selected pressure display in scaled format until SCALES / OFF is selected.

You can freeze a pressure waveform display to stabilize the waveform for measurements. To unfreeze the waveform display, select FREEZE / OFF or exit the pressure menu by touching either the PREVIOUS MENU or NORMAL SCREEN keys.

**Note:**

*If you touch NORMAL SCREEN when the pressure scales overlay a multizone parameter, such as GAS, the pressure scales will disappear.*

You can increase or decrease the pressure waveform scale. The lowest scale value is always 0 (zero). Set the top of the scale to be any value from 10 to 500 mmHg by typing in the desired value and touching ENTER.

<table>
<thead>
<tr>
<th>To configure pressure waveform display with a vertical scale:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch the desired pressure parameter key.</td>
</tr>
<tr>
<td>• Touch SCALES.</td>
</tr>
<tr>
<td>• Select SCALES ON to maintain the pressure in scaled format.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To freeze the pressure display:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch the desired pressure parameter key.</td>
</tr>
<tr>
<td>• Touch SCALES.</td>
</tr>
<tr>
<td>• Touch FREEZE / ON.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To change the pressure waveform scale:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch the desired pressure parameter key.</td>
</tr>
<tr>
<td>• Touch SCALES.</td>
</tr>
<tr>
<td>• Touch SCALE 0-xxx.</td>
</tr>
<tr>
<td>• Type a new scale.</td>
</tr>
<tr>
<td>• Touch ENTER.</td>
</tr>
</tbody>
</table>
Selecting the Waveform Measurement Value

You can obtain a measurement at any part of the pressure waveform using the horizontal cursor. The measurement value displays as CURSOR = xx in the message line above the Pressure Scales menu.

Common uses of this function are:

- Obtaining a pulmonary capillary wedge pressure (PCWP) value from the pulmonary artery catheter.
- Storing values in memory for later display using the Trend or Clinical Calculations features.

<table>
<thead>
<tr>
<th>To obtain a pulmonary capillary wedge pressure (PCWP):</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch PA.</td>
</tr>
<tr>
<td>• Inflate the PA catheter balloon.</td>
</tr>
<tr>
<td>• Touch SCALES.</td>
</tr>
<tr>
<td>• Touch FREEZE / ON.</td>
</tr>
<tr>
<td>• Deflate the PA catheter balloon.</td>
</tr>
<tr>
<td>• Use the arrow keys to position the cursor.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To store values in memory:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch the desired pressure parameter key.</td>
</tr>
<tr>
<td>• Touch SCALES.</td>
</tr>
<tr>
<td>• Use the arrow keys to position the cursor.</td>
</tr>
</tbody>
</table>

For ART, PRS, UA, and UV:

- Select SAVE SYS, SAVE DIA, or SAVE MEAN.

For CVP, RAP, LAP, or ICP:

- Touch SAVE MEAN.

For PA:

- Touch SAVE PCWP.
Printing Pressure Waveforms

You can print pressure waveforms and values. Refer to Printing on page 8-5 for additional information.

**Note:**

*Do not change the pressure scales during a recording. This may lead to an annotation on the recording that does not match the actual scale of the recording.*

---

**To print pressure waveforms:**

- Touch RECORD.
- Touch the flashing pressure parameter key.

---

Setting Artifact Rejection

Variations in intrathoracic pressures during the respiratory cycle can influence invasive pressures, especially PA, PCWP, and CVP. The respiratory artifact rejection feature minimizes the impact of such variations by automatically selecting data from waveform peaks that have little change in amplitude from peak to peak. End-expiration is typically the time with the least variation. The artifact rejection feature works equally well in both mechanically ventilated and spontaneously breathing patients.

In patients with chronic obstructive pulmonary disease, intrathoracic pressures during respiration are different than those in patients with normal lung function. Disable the artifact rejection feature when monitoring these patients.

---

**To activate respiration artifact rejection:**

- Touch the desired pressure parameter key.
- Touch SETUP.
- Select ART REJ / ON.
Selecting a Filter Frequency

You can adjust the filter frequency to minimize the effect of noise and other interference that appears on the pressure waveform. The filter frequency can be set within the range of 3 to 40 Hz.

A higher filter frequency shows greater detail, but may also show more artifact. A lower filter frequency smooths the waveform and may help diagnose transducer or catheter problems, such as under-damping or ringing.

When the filter is set to 30 Hz or higher, the frequency response of the equipment is such that sinusoidal output pressure at 10 Hz is within 3 dB of the pressure reading at 1 Hz.

To adjust the filter frequency:
- Touch the desired pressure parameter key.
- Touch SETUP.
- Touch FILTER.
- Touch the arrow keys to choose the desired setting.

Factory-Default Pressure Alarm Settings

Table 2: Arterial (ART), Generic Pressure (PRS), Umbilical Artery and Vein (UA and UV), Cerebral Perfusion (CPP)

<table>
<thead>
<tr>
<th>Systolic *</th>
<th>mmHg</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>-50 to 79</td>
<td>+30</td>
<td>-05</td>
<td></td>
</tr>
<tr>
<td>80 to 109</td>
<td>+30</td>
<td>-10</td>
<td></td>
</tr>
<tr>
<td>110 to 119</td>
<td>+30</td>
<td>-15</td>
<td></td>
</tr>
<tr>
<td>120 to 129</td>
<td>+25</td>
<td>-20</td>
<td></td>
</tr>
<tr>
<td>130 to 139</td>
<td>+20</td>
<td>-20</td>
<td></td>
</tr>
<tr>
<td>140 to 149</td>
<td>+15</td>
<td>-20</td>
<td></td>
</tr>
<tr>
<td>150 to 159</td>
<td>+10</td>
<td>-20</td>
<td></td>
</tr>
<tr>
<td>160 to 169</td>
<td>+10</td>
<td>-25</td>
<td></td>
</tr>
<tr>
<td>170 to 179</td>
<td>+10</td>
<td>-30</td>
<td></td>
</tr>
<tr>
<td>180 to 189</td>
<td>+10</td>
<td>-35</td>
<td></td>
</tr>
<tr>
<td>190 to 300</td>
<td>+10</td>
<td>-40</td>
<td></td>
</tr>
</tbody>
</table>
Pressure

### Systolic *

<table>
<thead>
<tr>
<th>kPa</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>-6.7 to 10.5</td>
<td>+4.0</td>
<td>-0.7</td>
</tr>
<tr>
<td>10.6 to 14.5</td>
<td>+4.0</td>
<td>-1.3</td>
</tr>
<tr>
<td>14.6 to 15.9</td>
<td>+4.0</td>
<td>-2.0</td>
</tr>
<tr>
<td>16.0 to 17.2</td>
<td>+3.3</td>
<td>-2.7</td>
</tr>
<tr>
<td>17.3 to 18.5</td>
<td>+2.7</td>
<td>-2.7</td>
</tr>
<tr>
<td>18.6 to 19.9</td>
<td>+2.0</td>
<td>-2.7</td>
</tr>
<tr>
<td>20.0 to 21.2</td>
<td>+1.3</td>
<td>-2.7</td>
</tr>
<tr>
<td>21.3 to 22.5</td>
<td>+1.3</td>
<td>-3.3</td>
</tr>
<tr>
<td>22.6 to 23.8</td>
<td>+1.3</td>
<td>-4.0</td>
</tr>
<tr>
<td>23.9 to 25.1</td>
<td>+1.3</td>
<td>-4.7</td>
</tr>
<tr>
<td>25.2 to 40.0</td>
<td>+1.3</td>
<td>-5.3</td>
</tr>
</tbody>
</table>

* Example: If systolic is between 80 and 109 mmHg, the HI alarm defaults to 30 mmHg above the actual value and the LO alarm defaults to 10 mmHg below the actual value.

### Diastolic

<table>
<thead>
<tr>
<th>mmHg</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>-50 to 69</td>
<td>+30</td>
<td>-05</td>
</tr>
<tr>
<td>70 to 79</td>
<td>+20</td>
<td>-10</td>
</tr>
<tr>
<td>80 to 89</td>
<td>+20</td>
<td>-15</td>
</tr>
<tr>
<td>90 to 99</td>
<td>+15</td>
<td>-15</td>
</tr>
<tr>
<td>100 to 109</td>
<td>+10</td>
<td>-20</td>
</tr>
<tr>
<td>110 to 119</td>
<td>+05</td>
<td>-25</td>
</tr>
<tr>
<td>120 to 300</td>
<td>+05</td>
<td>-30</td>
</tr>
</tbody>
</table>
## Pressure

### Diastolic

<table>
<thead>
<tr>
<th>kPa</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.7 to 9.2</td>
<td>+4.0</td>
<td>-0.7</td>
</tr>
<tr>
<td>9.3 to 10.6</td>
<td>+2.7</td>
<td>-1.3</td>
</tr>
<tr>
<td>10.7 to 11.8</td>
<td>+2.7</td>
<td>-1.9</td>
</tr>
<tr>
<td>11.9 to 13.2</td>
<td>+2.0</td>
<td>-1.9</td>
</tr>
<tr>
<td>13.3 to 14.5</td>
<td>+1.3</td>
<td>-2.7</td>
</tr>
<tr>
<td>14.6 to 15.8</td>
<td>+0.7</td>
<td>-3.3</td>
</tr>
<tr>
<td>15.9 to 40</td>
<td>+0.7</td>
<td>-4.0</td>
</tr>
</tbody>
</table>

### Mean

<table>
<thead>
<tr>
<th>mmHg</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>-50 to 69</td>
<td>+30</td>
<td>-5</td>
</tr>
<tr>
<td>70 to 79</td>
<td>+30</td>
<td>-10</td>
</tr>
<tr>
<td>80 to 99</td>
<td>+30</td>
<td>-15</td>
</tr>
<tr>
<td>100 to 109</td>
<td>+30</td>
<td>-20</td>
</tr>
<tr>
<td>110 to 119</td>
<td>+30</td>
<td>-25</td>
</tr>
<tr>
<td>120 to 129</td>
<td>+25</td>
<td>-30</td>
</tr>
<tr>
<td>130 to 139</td>
<td>+20</td>
<td>-30</td>
</tr>
<tr>
<td>140 to 149</td>
<td>+15</td>
<td>-30</td>
</tr>
<tr>
<td>150 to 179</td>
<td>+10</td>
<td>-30</td>
</tr>
<tr>
<td>180 to 300</td>
<td>+10</td>
<td>-35</td>
</tr>
</tbody>
</table>
### Mean

<table>
<thead>
<tr>
<th>kPa</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>-6.7 to 9.2</td>
<td>+4.0</td>
<td>-0.7</td>
</tr>
<tr>
<td>9.3 to 10.5</td>
<td>+4.0</td>
<td>-1.3</td>
</tr>
<tr>
<td>10.6 to 13.2</td>
<td>+4.0</td>
<td>-2.0</td>
</tr>
<tr>
<td>13.3 to 14.5</td>
<td>+4.0</td>
<td>-2.7</td>
</tr>
<tr>
<td>14.6 to 15.8</td>
<td>+4.0</td>
<td>-3.3</td>
</tr>
<tr>
<td>15.9 to 17.2</td>
<td>+3.3</td>
<td>-4.0</td>
</tr>
<tr>
<td>17.3 to 18.5</td>
<td>+2.7</td>
<td>-4.0</td>
</tr>
<tr>
<td>18.6 to 19.8</td>
<td>+2.0</td>
<td>-4.0</td>
</tr>
<tr>
<td>19.9 to 23.8</td>
<td>+1.3</td>
<td>-4.0</td>
</tr>
</tbody>
</table>

*Table 3: Pulmonary Artery (PA), Right Atrial (RAP), Central Venous (CVP), Left Atrial (LAP), and Intracranial (ICP-mean) Only*

### Systolic, Diastolic, and Mean

<table>
<thead>
<tr>
<th>mmHg</th>
<th>High</th>
<th>Low</th>
<th>kPa</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>-50 to 25</td>
<td>+05</td>
<td>-05</td>
<td>-6.7 to 3.3</td>
<td>+0.7</td>
<td>-0.7</td>
</tr>
<tr>
<td>26 to 300</td>
<td>+20%</td>
<td>-20%</td>
<td>3.4 to 40</td>
<td>+20%</td>
<td>-20%</td>
</tr>
</tbody>
</table>
## Invasive Pressure Troubleshooting Guide

<table>
<thead>
<tr>
<th>Clinical Situation</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermittent or no operation</td>
<td>Module error.</td>
<td>Contact your biomed or a qualified field service engineer.</td>
</tr>
<tr>
<td></td>
<td>Transducer not connected.</td>
<td>Reconnect the transducer.</td>
</tr>
<tr>
<td>No pressure key appears</td>
<td>Module not inserted correctly.</td>
<td>Reinsert the module.</td>
</tr>
<tr>
<td></td>
<td>Transducer not connected.</td>
<td>Reconnect the transducer.</td>
</tr>
<tr>
<td>Numeric display is not stable</td>
<td>Respiration artifact too high.</td>
<td>Select ART REJ / ON.</td>
</tr>
<tr>
<td>Pressure display disappears</td>
<td>Cable disconnected from the module.</td>
<td>Reconnect cable.</td>
</tr>
<tr>
<td></td>
<td>Cable disconnected from the</td>
<td>Reconnect cable.</td>
</tr>
<tr>
<td></td>
<td>transducer.</td>
<td></td>
</tr>
<tr>
<td>Pressure shows NOT ZEROED</td>
<td>Pressure has not been zeroed.</td>
<td>Zero the pressure with the ZERO key after opening transducer to air.</td>
</tr>
<tr>
<td>Shows constant pressure</td>
<td>Stopcock(s) positioned incorrectly.</td>
<td>Reposition stopcock(s) to connect the patient to the transducer (a waveform will appear on the display).</td>
</tr>
<tr>
<td>ZERO REJECTED message appears</td>
<td>Stopcock(s) positioned incorrectly.</td>
<td>Reposition stopcock(s) to open the transducer to air. Zero the pressure with the zero key.</td>
</tr>
<tr>
<td></td>
<td>Still unable to zero.</td>
<td>Follow transducer manufacturer’s instructions to correct the problem.</td>
</tr>
</tbody>
</table>
Directory of Keys

**ADULT NIBP MENU** - Next reading at HR:MIN

- **ALARM LIMITS**
- ** AUTO**
- **ON**
- **OFF**
- **TIME INTERVAL**
- **REVIEW**
- **CHANGE CONFIG.**
- **VENOUS STASIS**

**NIBP - CHANGE CONFIGURATION**

- **DISPLAY PR**
- **ADULT**
- **NEONATAL**

**NIBP - REVIEW**

- ←
- →
- →
- →
- PRINT

**TIME INTERVAL** for automatic readings = q xx yyy. Next reading at HR:MIN

- ↑
- ↓
- CHARTING
- RELATIVE
- RESET INTERVAL
- ON
- OFF
- TAKE AT
- START ON AUTO
- ON
- OFF

**ADULT NIBP - ALARM LIMITS**

- **ALARMS**
- **ON**
- **OFF**
- **HI** = 150
- **LO** = 100
- ↑
- ↓
- SYS
- DIA
- MEAN

Schedule a reading at this hour HR:MIN. Next reading at HR:MIN

- ↑
- ↓
Overview

Noninvasive blood pressure (NIBP) uses oscillometric monitoring to measure systolic (S), diastolic (D), and mean (M) arterial blood pressures. All monitors display the most recent reading with the time that the reading was initiated.

Bedside monitors store up to 120 readings and display a table of up to ten readings at one time (five readings if the pulse rate is displayed). Additional readings can be viewed by scrolling through additional pages of measurements.

Note:

- Blood pressure measurements determined with this module are equivalent to those obtained by a trained observer using the cuff/stethoscope auscultatory method, within the limits prescribed by the American National Standards Institute, with electronic or automated sphygmomanometers.
- Use only cuffs specified by Spacelabs Healthcare. Other cuffs may adversely affect performance and measurement accuracy.
- There are no hazards associated with using noninvasive blood pressure equipment during defibrillation or high-frequency electrosurgery, because both the cuff and cuff tubing are made of non-conductive materials.
- To define your own default parameter settings and alarm settings, refer to the Ultraview SL Module Configuration Manager System Administration Guide (P/N 070-1245-xx).
Warnings and Cautions

This chapter includes warnings and cautions specifically related to noninvasive blood pressure measurements. Refer to Warnings and Cautions on page 23-5 in the Product Specifications chapter for cautionary disclosures that apply to several physiological parameters or to the monitoring system itself.

Warning:

- During NIBP readings, the inflated cuff reduces blood flow to the limb to which it is applied. Consider this when taking frequent manual NIBP readings or when short time intervals for automatic NIBP readings are used. Check the patient periodically to ensure that the cuff does not impair limb circulation.
- Do not apply a cuff to a limb with restricted blood flow, such as a patient with a dialysis shunt or history of mastectomy.
- Do not apply the cuff to any extremity being used for intravenous infusion or catheterization.
- Do not apply the cuff to any area of breached or injured skin.

Caution:

- Use only specified extensions or adapters with the neonatal inflation tubing.
- Avoid compression or restriction of pressure in the NIBP patient connector tubes.
- The mode selected (ADULT or NEONATAL) must correlate with the type of patient wearing the cuff that connects to the hose connected to the module.

Selecting ADULT or NEONATAL Mode

The patient type selected in NIBP does not affect (and is not affected by) the patient type selected when admitting a patient. In modules that offer both ADULT and NEONATAL modes, you can determine the current mode by observing which key is highlighted or by reading the menu prompt in the NIBP menu.

To select the patient type:

- Touch NIBP.
- Touch CHANGE CONFIG.
- Select ADULT or NEONATAL.

The following events occur with each change of mode:

- Active NIBP alarm violations end.
- Alarm limits and status (ON/OFF) automatically change to reflect the new mode (ADULT or NEONATAL).
Setting Up NIBP Monitoring

Proper cuff selection and application are essential in ensuring the accuracy of NIBP readings. Improper cuff selection results in the greatest chance of error, therefore, a variety of cuff sizes should be available to accommodate your full patient population. If the cuff is too wide for the patient, the reading will be falsely lowered. If the cuff is too narrow for the patient, the reading will be falsely elevated.

To select the proper cuff, first measure the circumference of the limb (in centimeters) at its midpoint. Match the limb measurement to the circumference range specified on each cuff. When applied, the index line on a correctly sized cuff will fall within the designated range markings on the cuff.

The cuff should be snugly applied. When the cuff is properly applied, you should be able to insert one finger between the cuff and the limb. If you can insert two fingers, the cuff is too loose, which may result in falsely elevated readings. Ensure that the inflation tubing is not kinked or occluded when the cuff is applied.

Patient Factors Affecting Readings

Applying external pressure to the cuff during readings, excessive patient movement, speech, or muscle contractions (as a result of severe pain or shivering) can interfere with NIBP readings. Ensure that the patient is quiet and not moving during NIBP readings, just as you would during manual readings. Institute measures to minimize shivering and alleviate pain, if necessary.

Pressure also varies cyclically with normal respiration. With deep respirations, or in certain patients, this effect may be enhanced, increasing the variability of NIBP readings.

Obtaining NIBP readings can be more difficult in patients with arrhythmias. These arrhythmias increase the beat-to-beat pressure fluctuations during readings, which increases the variability of the NIBP readings. Temporarily verify pressure using another method if it becomes difficult to obtain readings in the presence of arrhythmias.

For patients in shock, indirect methods of measuring pressure (auscultatory, oscillometric, doppler) may not be reliable because of peripheral vascular changes. These changes include peripheral vasoconstriction and diminished peripheral circulation because of shunting of blood to central organs. In some cases, peripheral pulses or Korotkoff sounds may be diminished or disappear in spite of adequate blood pressure. In such cases, measuring a cuff pressure may be impossible or give misleading results. Direct (invasive) blood pressure measurements should be considered in patients with signs of shock or in any patient who rapidly becomes unstable for unknown reasons.
Display Detail

Figure 15-1 illustrates typical NIBP views. You can view the most recent NIBP reading from any bedside or central monitor on a network.

The START key initiates an immediate blood pressure measurement. While a measurement is in progress, the key changes to STOP.

Current interval for automatic readings (q 15 minutes). A q' in place of a q indicates that the reduced delay of five seconds between readings is active (refer to Automatic NIBP Measurements on page 15-9).

NIBP parameter key

Last systolic and diastolic readings

NIBP alarm limits. Bedside monitors display the high and low alarm limits for systole and diastole. The asterisk indicates that alarms are enabled for mean pressure.

Mean reading

Time and date of the last reading

NIBP measurement table (bedside monitors only)

Note:

If you remove one NIBP module and insert another without purging data (via the Admit/Discharge function), the NIBP table may display data for two patients.

The NIBP measurement table can display readings with or without a pulse rate. Ten measurements are displayed on each page of the NIBP table unless you choose to display the pulse rate. If the pulse rate is displayed, five measurements are displayed on each page of the NIBP table. Pulse rate is obtained from ECG, arterial pressure (ART), SpO2, and NIBP (in that order), depending on the availability of these parameters.
Reviewing NIBP Readings

To display pulse rate on the NIBP table:
- Touch NIBP.
- Touch CHANGE CONFIG.
- Select DISPLAY PR / ON.

To review NIBP measurements:
- Touch NIBP.
- Touch REVIEW.

Bedside monitors display a chronological listing of NIBP readings with the oldest data at the top of the left column. Each reading contains the time of the measurement and the pressure values for systolic, diastolic, and mean. As new measurements are taken, the oldest data moves off the display line-by-line.

You can review a patient’s NIBP measurements by scrolling through the measurement table line-by-line or page-by-page. To scroll line-by-line, touch the single-arrow keys.

To scroll page-by-page, touch the double-arrow keys:
- To review earlier measurements, touch the ← key or the ← key.
- To review later measurements, touch the → key or the → key.

Touch the | ← key to display the earliest page of readings.
Touch the →| key to display the latest page of readings.

Note:
*Because monitors display a full page of readings, some readings may appear on multiple pages when more than 5 or 10 NIBP measurements have been taken.*
Printing NIBP Readings

You can print the NIBP data in the following formats:

• Multiple readings
• NIBP data for the last reading only

To print the NIBP measurements currently displayed:

• Touch NIBP.
• Touch REVIEW.
• Touch PRINT.

To print the most recent measurement (no table):

• Touch the RECORD function key.
• Touch NIBP.

Taking NIBP Readings and Venous Stasis

At the beginning of a blood pressure measurement:

• The mean value of the previous reading disappears.
• The message READING IN PROGRESS replaces the diastolic value.
• A bleed step replaces the previously displayed systolic pressure.

If the system fails to complete an initial measurement reading, the message SECOND READING REQUIRED appears, along with a description of the cause of the failure. A second measurement attempt automatically begins after a short delay. The cuff must be deflated for at least 30 seconds (5 seconds in short-term AUTO mode) before a new reading can be initiated.

If the second attempt fails:

• The message NO READING appears.
• An alarm tone sounds (if alarms are turned ON and NO READING is set to sound a tone, as set in the Module Configuration Manager).
• One of the following messages appears:
  
  INFLATE ERROR
  HW ERROR
  NO DATA
If the system detects unstable beat-to-beat blood pressures during measurements, one of the following messages appears:

- MOTION (NEONATAL mode)
- ARTIFACT (ADULT mode)

Warning:
During NIBP readings, the inflated cuff reduces blood flow to the limb to which it is applied. Consider this when taking frequent manual NIBP readings or when short time intervals for automatic NIBP readings are used.

Deflating the NIBP Cuff

If you deflate the cuff during a reading, the reading ends and the messages NO READING and CUFF DEFLATE appear on the monitor.

To stop an NIBP measurement (or venous stasis) in process:
- Touch STOP.
- OR-
- Press the red Deflate button on the module.

If AUTO is set to ON, the next automatic measurement will start at the next scheduled interval after the completion of manual NIBP measurements or venous stasis.

Manual NIBP Measurements

Touch the START key (refer to Figure 15-1 on page 15-6) to start a measurement. If another measurement is already in progress, this key is labeled STOP.

To start a manual measurement, touch START.

Automatic NIBP Measurements

Use the TIME INTRVAL key to select a time interval for an automatic measurement. The current time interval for automatic measurements is displayed above the arrow keys and in the NIBP zone.

To determine automatic measurement intervals:
- Touch NIBP.
- Touch TIME INTRVAL.
- Use the arrow keys to adjust the interval.
Measurement Intervals

Measurement intervals are as follows:

- 1, 2, 3, 4, 5, 10, 15, 20, and 30 minutes
- 1, 2, 4, 6, or 8 hours

For time intervals of less than five minutes, special allowances are made for a rapid succession of readings. For the first 15 minutes after you set up a reading (turn AUTO MODE ON or select a new time interval), the minimum delay between readings is five seconds (this is the short-term AUTO mode).

When this five-second delay is active, the interval message appears with an apostrophe after the q (q'). After the 15-minute period, the minimum delay between automatic readings becomes 30 seconds. However, you can touch START at any time to take a reading, and it will have a maximum delay of 5 seconds.

Automatic Measurement Modes (AUTO MODE)

You can press a key on the Time Interval menu to select either Charting Mode or Relative Mode. You can select Charting Mode or Relative Mode whether automatic NIBP measurements are turned ON or OFF. AUTO MODE will not be activated until NIBP measurements are turned ON.

If automatic measurements are turned ON, the time of the next scheduled reading appears in the prompt line, and a reading may be taken immediately (refer to START ON AUTO on page 15-12). If automatic readings are turned OFF, the message NO READING appears on the prompt line.

Charting Mode

When the CHARTING key is selected, all automatic NIBP readings are synchronized to start at the next even time interval conducive for charting. For example, if a 15-minute interval was selected, and the current time is 14:07, automatic readings would be initiated at 14:15, 14:30, 14:45, and 15:00.

Relative Mode

When the RELATIVE key is selected, automatic NIBP readings are synchronized to when AUTO was turned ON or the last manual NIBP measurement. For example, if a 15-minute interval was selected and AUTO was turned ON at 8:57, readings would be initiated at 9:12, 9:27, 9:42, and 9:57.

To select Charting or Relative Mode:

- Touch NIBP.
- Touch TIME INTERVAL.
- Touch CHARTING/RELATIVE.

Note:

- If the system time is changed by 10 minutes or less, automatic readings are not rescheduled. However, if a reading will be missed due to the time change, that reading will be taken immediately.

- If the system time is changed by more than 10 minutes, the time of the next blood pressure measurement is recalculated. Any reading that would have been skipped by changing the time is not taken.
• If the system time is changed, and CHARTING MODE is selected, the reading will occur at the next scheduled time.
• If the system time is changed, and RELATIVE MODE is selected, the reading is scheduled from the new time, just as if the interval were changed.

RESET INTERVAL

The RESET INTERVAL key is only available when Relative Mode is selected. If the RESET INTERVAL key is ON, the automatic NIBP measurement interval is reset whenever a manual NIBP measurement is initiated.

For example, if the automatic interval is 15 minutes, and if readings are automatically taken at 8:05 and 8:20, and then the caregiver initiates a manual NIBP measurement at 8:30, the next automatic reading would be at 8:45. If the RESET INTERVAL key is OFF, taking the manual NIBP measurement has no effect, and the next automatic reading would be taken at 8:35.

<table>
<thead>
<tr>
<th>To turn Reset Interval ON:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch NIBP.</td>
</tr>
<tr>
<td>• Touch TIME INTRVAL.</td>
</tr>
<tr>
<td>• Touch RESET INTERVAL / ON.</td>
</tr>
</tbody>
</table>

TAKE AT

The TAKE AT key is enabled with Charting Mode, when the NIBP measurement interval is two hours or greater. Touching the TAKE AT key opens a new menu with two arrow keys. Use the arrow keys to schedule an hour for an NIBP measurement.

For example, if a four-hour interval is selected in Charting Mode, and TAKE AT is set to 5:00, the NIBP measurement will be scheduled at 5:00, 9:00, and so on.

<table>
<thead>
<tr>
<th>To schedule an NIBP measurement using TAKE AT:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch NIBP.</td>
</tr>
<tr>
<td>• Touch TIME INTRVAL.</td>
</tr>
<tr>
<td>• Use the arrow keys to adjust the interval.</td>
</tr>
<tr>
<td>• Touch CHARTING.</td>
</tr>
<tr>
<td>• Touch TAKE AT.</td>
</tr>
<tr>
<td>• Use the arrow keys to select the time of the NIBP measurement.</td>
</tr>
</tbody>
</table>
START ON AUTO

The START ON AUTO key determines whether or not a blood pressure reading is immediately taken when the automatic NIBP readings are initially turned ON or set to ON.

However, setting the START ON AUTO key to ON will not cause a reading to be taken when the reading interval set in Charting Mode is changed (the reading is already scheduled to occur).

<table>
<thead>
<tr>
<th>To enable START ON AUTO:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch NIBP.</td>
</tr>
<tr>
<td>• Touch TIME INTERVAL.</td>
</tr>
<tr>
<td>• Touch START ON AUTO.</td>
</tr>
</tbody>
</table>

Venous Stasis

The venous stasis feature uses the NIBP cuff as the tourniquet for venous cannulation.

When enabled in the Module Configuration Manager, the cuff is inflated and pressure is held constant as follows:

- Neonatal — 40 mmHg for one minute
- Adult — 60 mmHg for two minutes

If the mean arterial pressure (MAP) of the last blood pressure is less than 50 mmHg (neonatal) or 70 mmHg (adult), the stasis cuff pressure will be 10 mmHg below the MAP.

Note:

*The VENOUS STASIS key displays if the venous stasis feature is enabled.*

<table>
<thead>
<tr>
<th>To start venous stasis:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch NIBP.</td>
</tr>
<tr>
<td>• Touch VENOUS STASIS.</td>
</tr>
</tbody>
</table>
When venous stasis begins:

- The START key changes to STOP.
- The cuff inflates to a constant pressure (as previously noted).
- The NIBP measurements table is replaced by the words VENOUS STASIS and CUFF PRESSURE. The cuff pressure value updates every three seconds.
- The time remaining in seconds displays to the right of the NIBP parameter key. When the stasis pressure is reached, the timer starts counting down in five-second intervals until it reaches 15 seconds.
- During the last 15 seconds of the stasis, the words VENOUS STASIS flash to advise of the limited time remaining, and the timer decrements in one-second intervals.
- When the timer counts down to zero, the cuff automatically deflates, the STOP key changes to START, and the NIBP measurements table is restored.

Enabling and Adjusting Alarms

Refer to Setting Alarm Limits on page 6-7 for details on operating system alarms.

To enable and adjust alarms:

- Touch NIBP.
- Touch ALARM LIMITS.
- Select SYS, DIA, or MEAN.
- Select ALARMS / ON.
- Select HI= or LO=.
- Use the arrow keys to adjust.
## NIBP Troubleshooting Guide

<table>
<thead>
<tr>
<th>Clinical Situation</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No NIBP display key is displayed</strong></td>
<td>• Module is not inserted correctly.</td>
<td>• Remove and re-insert the module.</td>
</tr>
<tr>
<td><strong>No NIBP readings can be obtained</strong></td>
<td>• Incorrect or inoperative cuff is in use.</td>
<td>• Replace with a cuff known to be operative.</td>
</tr>
<tr>
<td></td>
<td>• Cuff tubing is attached to an adult connector, but the monitor is configured in NEONATAL mode (or vice versa).</td>
<td>• Connect the tubing to the correct connector. Correlate MONITOR mode, cuff, and patient type.</td>
</tr>
<tr>
<td></td>
<td>• Tubing is kinked.</td>
<td>• Locate the kink and straighten the tubing.</td>
</tr>
<tr>
<td></td>
<td>• Some arrhythmias (for example, atrial fibrillation and frequent ventricular ectopy) may cause a single or repeated failure to obtain a reading (may be because of true beat-to-beat variations in pressure).</td>
<td>• Document arrhythmia, if present, verify pressure with another method, then follow hospital procedure for care of this type of patient.</td>
</tr>
<tr>
<td></td>
<td>• Excessive patient motion or muscle contractions associated with shivering or severe pain.</td>
<td>• Ensure patient is quiet with minimal movement during NIBP readings. Minimize the patient’s shivering.</td>
</tr>
<tr>
<td></td>
<td>• Blood pressure is outside of the measurement range.</td>
<td>• Verify extremely high or low pressures with another method.</td>
</tr>
<tr>
<td><strong>Intermittent or complete failure to operate</strong></td>
<td>• Hardware error (codes 10, 20, and 30) detected during previous measurement.</td>
<td>• Check for the presence of the RESET NIBP key in the <strong>Change Configuration</strong> menu. Touch RESET NIBP to re-enable monitoring.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Remove the module from service and call your biomed a qualified field service engineer if this condition occurs repeatedly.</td>
</tr>
</tbody>
</table>
### Intermittent or complete failure to operate (continued)

- Hardware error causing the NIBP portion of the module to be inoperable. The *NIBP SYSTEM FAULT ERROR NO. = XX* (bedside monitor only) or *HW ERROR* (bedside monitors and remote monitors) message appears.

  - Check for the presence of the RESET NIBP key in the **Change Configuration** menu. Touch RESET NIBP to re-enable monitoring.

  - Remove the module from service and call your biomed or a qualified field service engineer if this condition occurs repeatedly.

### CUFF CANNOT BE DEFLATED

- The deflate hardware is blocked and the cuff cannot be deflated.

  - Check for the presence of the RESET NIBP key in the **Change Configuration** menu. Touch RESET NIBP to re-enable monitoring.

  - Remove the cuff from the limb immediately and have the module serviced by biomed or a qualified field service engineer.

### Apparent incorrect value

- Wrong size cuff for patient.

- Cuff is damaged.

- Excessive patient motion, shivering, or severe pain.

- False high readings may be the result of venous congestion caused by frequent readings.

- Cuff too loose or positioned incorrectly.

  - Measure patient’s limb at the midpoint. Match limb measurement to the range specified on the cuff (undersizing the cuff results in the greatest degree of error).

  - Replace with a good cuff.

  - Ensure that the patient is quiet with minimal movement during NIBP readings. Minimize the patient’s shivering and pain.

  - Reduce the frequency of the readings.

  - Tighten the cuff or reposition it appropriately.
### NIBP

<table>
<thead>
<tr>
<th>Clinical Situation</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable readings occur</td>
<td>Some arrhythmias may cause beat-to-beat pressure variations between NIBP readings.</td>
<td>Document the arrhythmia, if present. Verify the pressure using another method, then follow hospital procedure for care of this type of patient.</td>
</tr>
<tr>
<td></td>
<td>Larger than normal influence of respiratory phases on blood pressure (inspiratory fall in blood pressure; expiratory rise).</td>
<td>NIBP software usually compensates for normal variation.</td>
</tr>
<tr>
<td>No NIBP readings or questionable values in the presence of shock</td>
<td>Peripheral vascular changes experienced during shock may reduce the reliability of blood pressure readings obtained with any indirect method. Peripheral pulses may be diminished or absent.</td>
<td>Consider invasive pressure measurements in patients with symptoms of shock or in any patient who rapidly becomes unstable for unknown reasons.</td>
</tr>
</tbody>
</table>
Respiration

Directory of Keys

ECG

Refer to page 16-2

Refer to page 16-3
Varitrend 3

Note:
The RESP WAVE SIZE key changes to RESP RATE SCALE if RESP RATE is selected on the Varitrend Main menu.
Overview

Changes in thoracic impedance during patient inspiration and expiration provide respiration data through the ECG cable. Lead selection for respiration is independent from the lead selection for ECG, even though both receive data from the same electrodes.

The Respiration function:

- Displays a waveform representing each breath.
- Provides the respiration rate.
- Detects and rejects cardiovascular artifact.
- Initiates alarms when limits are violated for either the respiration rate or apnea.

Varitrend 3, an optional feature in some modules with ECG, generates a graph of heart rate, SpO₂, and respiratory rates. You can view this graph on the monitor display or print it. The Varitrend 3 Event Trend feature enables you to detect apparent life threatening events such as bradycardia with desaturation or apnea, accompanied by a change in heart rate. This feature displays bradycardia, tachycardia, apnea, and desaturation trends for viewing and printing. A 24-hour trend of events is maintained, and up to 48 events are stored in memory. Refer to Configuring Varitrend 3 Graphs on page 16-12 for additional information.

Warning:

- Do not use this device to detect obstructive or mixed apneas. This device’s respiration function detects central apnea, but does not recognize obstructive and mixed apneas.

- The respiration function’s apnea alarm occurs when a preset time has elapsed since the last detected breath. The safety and effectiveness of the respiration function for the detection of apnea has not been established, particularly for the apnea of prematurity and the apnea of infancy.
Warnings and Cautions

This chapter includes warnings and cautions specifically related to respiration monitoring. Refer to Warnings and Cautions on page 23-5 in the Product Specifications chapter for cautionary disclosures that apply to electrodes and lead wires, defibrillators (including automatic implantable cardiac defibrillators), pacemakers, electrosurgical activity, several physiological parameters, or to the monitoring system itself.

Warning:

Some rate adaptive implanted pacemakers alter their rate based on the patient's Minute Volume. These pacemakers may occasionally be confused by the signal that a patient monitor uses to measure the patient's thoracic impedance (to determine respiration rate). When this occurs, these pacemakers may begin pacing at their maximum programmed rate. Turning the RESP channel OFF can prevent this.

Setting Up Respiration Monitoring

The RESP key must be set to ON in the ECG Display Format menu to display the RESP parameter key.

Note:

To define your own default parameter settings and alarm settings, refer to the Ultraview SL Module Configuration Manager System Administration Guide (P/N 070-1245-xx).

Caution:

If you suspend ECG processing using the SUSPEND PROCESSING key in the ECG menu, you also suspend respiration processing.

To set up respiration monitoring:

- Attach the patient ECG leads (as described in Patient Preparation and Electrode Application on page 9-7).
- Plug the ECG cable into the module's ECG input.
- Touch ECG.
- Touch DISPLAY FORMAT.
- Select RESP / ON.
- Touch RESP.
- Select additional keys as necessary.
Display Detail

Figure 16-1 shows the appearance of the Respiration parameter on the monitor display.

![Bedside monitor](image)

*RA-LA APN 15s

1. Respiration waveform
2. RESP parameter key
3. Respiration indicator (flashes once per detected breath)
4. Selected lead for respiration
5. Apnea alarm limit in seconds
6. High respiratory rate alarm limit
7. Low respiratory rate alarm limit
8. Current respiratory rate

Selecting ADULT or INFANT Mode

The respiration function provides both adult and infant operational modes to optimize monitoring accuracy. When you select ADULT or INFANT, respiration alarm limits and breath detection sensitivity are adjusted based upon your selection.

Caution:
When INFANT is selected, alarm activation for ECG and respiration can be delayed for up to three minutes. Closely observe the patient during this period.
Respiration

Adjusting Respiration Sensitivity

You can select shallow or normal input sensitivities for respiration monitoring based on the patient’s respiratory effort. Use the SHALLOW mode if the monitor has difficulty counting the respiratory rate or the waveform is difficult to read. Selecting SHALLOW also lowers the detection sensitivity nearer to the low amplitude waveform of infants.

To specify the patient type:

- Touch ECG.
- Touch SETUP.
- Touch CONFIG.
- Select ADULT or INFANT.

To adjust respiration monitoring sensitivity:

- Touch RESP.
- Select SHALLOW or NORMAL.

Using the Cardiovascular Artifact Filter

Respiration is monitored based on impedance changes that occur with the expansion and contraction of the chest. However, the physical action of the heart pumping blood and the flow of blood through the vasculature also create changes in impedance known as cardiovascular artifact (CVA). In the absence of respiration (for example, during episodes of apnea), the waveform in the respiration zone may represent CVAs rather than true respirations. In such cases, the respiratory rate is the same as the heart rate.

The CVA detection filter provides a method of discriminating between true respiratory effort and cardiac activity. The filter checks for coincidence between the respiratory rate and the heart rate.

If the rates are the same:

- The digital display for respiratory rate changes to CVA.
- A CVA message appears in the waveform zone.
- An apnea alarm is triggered (if it is enabled).

This minimizes the possibility of apneic episodes going undetected because of CVA. Episodes of CVA are reflected with a respiratory rate of zero in the trends.

If the patient’s respiratory and heart rates are identical, you may want to disable the CVA filter to avoid an apnea alarm.
Warning:

*If you disable the CVA detection filter, you will not be alerted to the presence of CVA if it replaces the respiration waveform.*

To enable/disable the CVA filter:

- Touch RESP.
- Select CVA FILTER / ON or OFF.

## Selecting Respiration Leads

Respiration lead selections (using the AAMI electrode identifier from *Table 1*) are RL-LA, RA-LA, RA-LL, and RL-LL.

- RA-LA represents the line of maximum respiratory effort in adults and chest-breathing infants.
- RA-LL represents the line of maximum respiratory effort in abdominal-breathing infants.

### Table 1: Electrode Color and Identifier Codes

<table>
<thead>
<tr>
<th>AAMI Electrode Identifier</th>
<th>AAMI Color Code</th>
<th>Electrode Placement</th>
<th>IEC Electrode Identifier</th>
<th>IEC Color Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>RA</td>
<td>White</td>
<td>Right Arm</td>
<td>R</td>
<td>Red</td>
</tr>
<tr>
<td>LA</td>
<td>Black</td>
<td>Left Arm</td>
<td>L</td>
<td>Yellow</td>
</tr>
<tr>
<td>LL</td>
<td>Red</td>
<td>Left Leg</td>
<td>F</td>
<td>Green</td>
</tr>
<tr>
<td>RL</td>
<td>Green</td>
<td>Right Leg</td>
<td>N</td>
<td>Black</td>
</tr>
</tbody>
</table>

To select respiration leads:

- Touch RESP.
- Touch LEAD SELECT.
- Select the appropriate lead configuration.
Maximum Impedance Change
Position RA and LA electrodes at the nipple level, anterior axillary line. Position LL below the diaphragm and preferably below the umbilicus.

Alternate Method
Position RA and LA electrodes at the 2nd intercostal space, midclavicular line. Position LL below the diaphragm, preferably below the umbilicus.

Enabling and Adjusting Alarms
Refer to Setting Alarm Limits on page 6-7 for details on operating system alarms.

To enable and adjust respiration rate alarms:
- Touch RESP.
- Touch ALARM LIMITS.
- Select HI/LO / ON.
- Select HI = or LO =.
- Use the arrow keys to adjust.

To enable and adjust apnea alarms:
- Touch RESP.
- Touch ALARM LIMITS.
- Select APNEA / ON.
- Touch APNEA =.
- Use the arrow keys to adjust.
Respiration

Note:

If the alarm limit for high rate or low rate appears as reverse video, the Alarm Tone and Alarm Recording features are disabled.

The apnea alarm limit is the maximum duration allowed between breaths before the respiration rate is set to zero. The apnea alarm limit can be set from 5 to 40 seconds in 5-second increments.

- If APNEA is turned ON, the apnea alarm will sound when the apnea limit is reached.
- If APNEA is turned OFF, the respiration rate will be set to zero after 20 seconds or when the apnea alarm limit is reached, whichever is greater. If the low rate alarm is ON, it will sound 10 seconds after the rate is set to zero.

Selecting Other Settings

You can turn the waveform OFF and display only the numeric values. When the waveform is OFF, the SWEEP SPEED key and the SIZE keys are disabled.

If the waveform is too large to fit within the display zone, use the waveform SIZE keys to adjust the display size. This does not affect the signal gain or breath detection sensitivity.

The sweep speed determines the speed at which the respiration waveform moves across the display.

You can select an audible tone to sound with each respiratory cycle. The tone volume is adjustable or can be disabled.

<table>
<thead>
<tr>
<th>To turn the waveform display ON or OFF:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch RESP.</td>
</tr>
<tr>
<td>• Select WAVEFORM / ON or OFF.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To adjust the waveform size:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch RESP.</td>
</tr>
<tr>
<td>• Touch SIZE.</td>
</tr>
<tr>
<td>• Adjust the waveform size using SIZE ↑ or SIZE ↓.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To select a waveform sweep speed:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch RESP.</td>
</tr>
<tr>
<td>• Touch SWEEP SPEED.</td>
</tr>
<tr>
<td>• Select the desired speed.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To adjust the respiration tone volume:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch RESP.</td>
</tr>
<tr>
<td>• Touch RESP TONE.</td>
</tr>
<tr>
<td>• Select TONE ON.</td>
</tr>
<tr>
<td>• Adjust the tone volume using VOLUME ↑ or VOLUME ↓.</td>
</tr>
</tbody>
</table>
Respiration

Printing Respiration Waveforms

You can print respiration waveforms and values. Refer to Printing on page 8-5 for additional information.

<table>
<thead>
<tr>
<th>To print respiration waveforms:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch RECORD on the monitor.</td>
</tr>
<tr>
<td>• Touch the flashing RESP parameter key.</td>
</tr>
</tbody>
</table>

Configuring Varitrend 3 Graphs

**Note:**
*If the VARITREND ON/OFF key does not appear in the ECG Display Format menu, your module does not include the Varitrend option.*

In Varitrend 3, trends for heart rate and SpO₂ appear in the upper half of the zone. Either the respiration rate trend or the compressed respiration waveform appear in the lower half of the zone.

<table>
<thead>
<tr>
<th>To turn Varitrend 3 ON or OFF:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch ECG.</td>
</tr>
<tr>
<td>• Touch DISPLAY FORMAT.</td>
</tr>
<tr>
<td>• Select VARITREND / ON or OFF.</td>
</tr>
</tbody>
</table>

Setting the Time Scale

You can set the time scale for the horizontal axis at either 1.5 or 3.0 minutes.

<table>
<thead>
<tr>
<th>To set the horizontal time scale:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch VARI.</td>
</tr>
<tr>
<td>• Select 1.5 MIN or 3.0 MIN.</td>
</tr>
</tbody>
</table>
Respiration

Selecting Respiratory Display Type and Waveform Size

Either the current respiration rate trend (RESP RATE) or the compressed respiration waveform (RESP WAVE) appears in the lower portion of the zone.

When you select RESP WAVE, the message RESP WAVEFORM appears next to the vertical axis instead of scale values. You can adjust the size of this waveform.

<table>
<thead>
<tr>
<th>To select the type of respiratory display:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch VARI.</td>
</tr>
<tr>
<td>• Select RESP RATE or RESP WAVE.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To select the waveform size when RESP WAVE is selected:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch VARI.</td>
</tr>
<tr>
<td>• Touch SIZE.</td>
</tr>
<tr>
<td>• Touch RESP WAVE SIZE.</td>
</tr>
<tr>
<td>• Use the arrow keys to adjust.</td>
</tr>
</tbody>
</table>

Selecting Rate and SpO\textsubscript{2} Scales

You can adjust the scales for respiration rate, heart rate, and SpO\textsubscript{2} trends:

• Scale selections for the respiration rate trend are 0–50, 0–100, 0–150, or 0–200 breaths per minute.
• Scale selections for the heart rate trend are 0–100, 0–150, 0–200, 0–250, 0–300, 50–150, 100–200, 100–250, and 100–300 beats per minute.
• Scale selections for the SpO\textsubscript{2} trend are 0–100%, 25–100%, 50–100%, and 75–100%.

<table>
<thead>
<tr>
<th>To select rate or SpO\textsubscript{2} scales:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch VARI.</td>
</tr>
<tr>
<td>• Touch SIZE.</td>
</tr>
<tr>
<td>• Touch RESP RATE SCALE, HR SCALE, or SPO2 SCALE.</td>
</tr>
<tr>
<td>• Use the arrow keys to adjust.</td>
</tr>
</tbody>
</table>

Defining Events

The Event Trend feature of Varitrend 3 enables you to store events that represent a change in a patient’s condition based on multiple variables. You can define criteria for up to five different events. For example, you may want to store episodes where the heart rate drops to less than 100 bpm, apnea lasts for more than 20 seconds, or the SpO\textsubscript{2} value drops to less than 85%.

The patient’s status is continually checked against each event definition. If any of the criteria are violated, a snapshot of the Varitrend 3 display representing this deviation is stored. The event is also added to the event trend.
Note:

A previously entered event definition cannot be edited directly. To change the definition, clear the existing definition and redefine the event as desired.

### To define an event:

- Touch VARI.
- Touch EVENT TREND.
- Touch DEFINE EVENT
- Select the event(s) to define.
- Use the arrow keys to adjust.
- Touch ENTER.
- The event definition displays to the right of the event definition keys in the Varitrend display zone.

### To clear an event definition:

- Select the event definition key in the Varitrend display zone.
- Touch CLEAR.

### Displaying Event Trends

Events are trended according to their duration and frequency. Regardless of the defining criteria, all events are grouped together in the Event Trend graph (refer to Figure 16-3). You can select to view these trends in 6-, 12-, or 24-hour time periods.

**The resolutions for these timebases are:**

- 15 minutes for a 6-hour trend
- 30 minutes for a 12-hour trend
- 60 minutes for a 24-hour trend

The top trend displays the duration of the longest event in each time period. The bottom trend displays the number of events that occurred during each time period. Scaling, for the vertical axis for each trend, is automatically adjusted based upon patient data.
Respiration

Event bar graph

60-minute resolution

Figure 16-3: Event Trend graph

Note:

Events longer than four minutes are reported as four-minute events.

To display event trends:
• Touch VARI.
• Touch EVENT TREND.
• Touch TREND.

To print event trends:
• Touch VARI.
• Touch EVENT TREND.
• Touch PRINT.
-OR-
• Touch TREND and then touch PRINT.
Clearing Events

If you choose to clear a single event, the data that represent that episode is removed from the event trends. You may also clear all events and trends. This has no effect on the event definitions.

To clear events:

- Touch VARI.
- Touch EVENT TREND.
- Touch CLEAR EVENT.
- Select CLEAR THIS EVENT or CLEAR ALL EVENTS.

Printing Varitrend 3 Graphs

You can print the currently displayed Varitrend 3 graph. Refer to Printing on page 8-5 for a complete overview of printer functions.

To print a Varitrend 3 graph:

- Touch VARI.
- Touch PRINT.
## Respiration Troubleshooting Guide

<table>
<thead>
<tr>
<th>Clinical Situation</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inaccurate respiratory rate or zero is displayed. Question marks are displayed instead of rate.</td>
<td>■ Respiration too shallow for normal detection.</td>
<td>■ Touch the SHALLOW/NORMAL key to highlight SHALLOW.</td>
</tr>
<tr>
<td></td>
<td>■ ECG electrode contact or placement is poor.</td>
<td>■ Apply new electrodes. Make sure to properly prepare the skin. Position electrodes on the chest where the chest expansion is the greatest.</td>
</tr>
<tr>
<td></td>
<td>■ Incorrect lead selection for respiration.</td>
<td>■ Select the appropriate lead. Best lead selection is typically RA-LA for adults and RA-LL for infants.</td>
</tr>
<tr>
<td></td>
<td>■ CVA artifact.</td>
<td>■ Assess the patient for apnea. Reselect lead for better signal quality.</td>
</tr>
<tr>
<td>No respiration waveform. LOSS OF SIGNAL message appears.</td>
<td>■ ECG electrodes or patient cable not attached.</td>
<td>■ Select another lead.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>■ Reconnect the leads or the patient cable.</td>
</tr>
<tr>
<td>No respiration waveform is displayed.</td>
<td>■ The module is not configured to display respiration.</td>
<td>■ Select RESP ON in the ECG Display Format menu.</td>
</tr>
</tbody>
</table>
SpO2

Directory of Keys — Spacelabs Healthcare SpO2 Technology

- SPO2
- SPO2 MENU
- SPO2 - SETUP
  - SIZE
  - WAVEFORM
    - ON
    - OFF
  - AVERAGING
    - ON
    - OFF
  - TONE
    - ON
    - OFF
    - VOLUME ↑
    - VOLUME ↓
- SPO2 - TONE
- SPO2 - DATA AVERAGING TIME = XXs
- SPO2 - WAVEFORM SIZE
  - SIZE ↑
  - SIZE ↓
- SPO2 - SUSPEND PROCESSING
  - YES
  - NO
- SPO2 - SETUP
  - IABP
    - YES
    - NO
  - PULSE RATE
    - ON
    - OFF
  - SUSPEND PROCESSING
    - YES
    - NO
- SPO2 - ALARM LIMITS
  - HI = 100
  - LO = 85
  - ALM DELAY = 15s
  - MSG ALARM DELAY = 30s

This key displays only when its value is other than 20 seconds

Ultraview SL2200 Operations Manual

17-1
Directory of Keys — Nellcor OxiMax SpO2 Technology

SP02 MENU

SP02 - SUSPEND PROCESSING

SP02 - SETUP

SP02 - TONE

SP02 - WAVEFORM SIZE

SP02 - ALARM LIMITS

SP02- ALARM LIMITS

ALARM LIMITS

PULSE RATE

SUSPEND PROCESSING

SUSPEND ON NIBP

SP02 MENU

SETUP

PULSE RATE

ON OFF

RESPONSE MODE

NORMAL FAST

TONES

VOLUME ↑ VOLUME ↓

SIZE ↑ SIZE ↓

ALARM LIMITS

HI = 100 LO = 85 SatSecs OFF NO PULSE

ON OFF

This key displays only when the NO PULSE alarm tone MCM setting is other than NONE.
Directory of Keys — Masimo SET SpO₂ Technology

### SPO₂ MENU
- **ALARM LIMITS**
- **SETUP**
- **PULSE RATE**
- **ON**
- **OFF**
- **SUSPEND PROCESSING**
- **SUSPEND ON NIBP**
  - **YES**
  - **NO**

### SPO₂ - SUSPEND PROCESSING
- **YES**
- **NO**

### SPO₂ - SETUP
- **SIZE**
- **WAVEFORM**
- **ON**
- **OFF**
- **AVERAGING**
- **TONES**
- **SENSITIVITY**
- **FAST SAT**
  - **ON**
  - **OFF**

### SPO₂ - SENSITIVITY MODE
- **NORMAL**
- **MAXIMUM**
- **APOD**

### SPO₂ - TONE
- **TONES**
  - **ON**
  - **OFF**
- **VOLUME**
  - **↑**
  - **↓**

### SPO₂ - DATA AVERAGING TIME = XXs
- **↑**
- **↓**

### SPO₂ - WAVEFORM SIZE
- **SIZE**
  - **↑**
  - **↓**

### SPO₂ - ALARM LIMITS
- **ALARMS**
- **ON**
- **OFF**
- **HI = 100**
- **LO = 85**
- **ALM DELAY**
  - **OFF**
  - **↑**
  - **↓**
SpO₂

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Overview

Pulse oximetry is used to continuously and noninvasively measure functional oxygen saturation in the blood. Pulse oximetry is measured by using changes in light absorption, as the light passes over a pulsating arteriolar bed. Pulse oximetry is also used to continuously and noninvasively measure pulse rate, using an SpO₂ sensor.

The pulse oximetry sensor contains two light-emitting diodes (LEDs). These LEDs emit specific wavelengths of red and infrared light, which are measured by a photo detector. The monitor displays this functional oxygen saturation as percent SpO₂.

The amount of light absorbed by the arteriolar bed varies during pulsations. During systole, a pulse of arterial blood enters the vascular bed, increasing the blood volume and light absorption. During diastole, blood volume and light absorption reach their lowest point. The pulse oximeter’s SpO₂ measurement depends on the difference between the maximum and minimum absorption (systole and diastole, respectively).
Traditional Pulse Oximetry

Traditional pulse oximetry is based on two principles:

- Oxyhemoglobin and deoxyhemoglobin differ in their absorption of red and infrared light (spectrophotometry).
- The volume of arterial blood in tissue and the light absorbed by the blood changes during the pulse (plethysmography).

Traditional pulse oximetry assumes that all of the pulsations in the light absorbance signal are due to oscillations in the arterial blood volume. Therefore, the blood flow in the region of the sensor passes entirely through the capillary bed. Concentrating on the light absorption of pulsatile arterial blood eliminates the effects of non-pulsatile absorbers (such as bone, tissue, pigmentation, and venous blood), which normally absorb a constant amount of light over time.

Oxyhemoglobin and deoxyhemoglobin differ in light absorption. The amount of red and infrared light absorbed by blood can be used to calculate the ratio of oxygenated hemoglobin to total hemoglobin in arterial blood, at each of two wavelengths (such as 660 nm and 940 nm). This ratio is translated into the functional oxygen saturation (SpO2) measurement that the monitor displays.

Note:

- Because SpO2 measurements depend upon light from a sensor, excessive ambient light can interfere with the pulse oximeter’s measurements.
- This pulse oximeter measures functional saturation, which is essentially the percentage of hemoglobin that can transport oxygen (oxyhemoglobin). Pulse oximeters do not detect significant amounts of dysfunctional hemoglobins, such as carboxyhemoglobin or methemoglobin, which cannot carry oxygen. Saturation measurements from pulse oximeters cannot be directly compared to measurements from a laboratory co-oximeter. Co-oximeters provide a fractional saturation (SaO2) value by measuring each type of hemoglobin individually. This fractional value is the ratio of oxygenated hemoglobin to all measured (oxygenated and dysfunctional) hemoglobins.
- A pulse oximeter SpO2 measurement may not match the saturation calculated from a blood gas partial pressure of oxygen (PO2). The most likely reason is that the calculated saturation value was not corrected to reflect the effects of variables that alter the relationship of PO2 and pH. Such variables can include temperature, the partial pressure of carbon dioxide (PCO2), 2,3-DPG, and fetal hemoglobin.

Monitoring of two SpO2 sites, if clinically necessary, may be accomplished by inserting a second SpO2 module into an available slot in the monitor or module housing. Affix a label to the monitor’s bezel to indicate the sensor site location (for example, right hand, left foot) for each SpO2 parameter displayed on the monitor. Take care to ensure that the two sensors remain apart so that they do not interfere with each other’s measurements.

During magnetic resonance imaging (MRI) procedures, do not use the pulse oximeter or oximetry sensors, for the following reasons:

- the pulse oximeter may interfere with the MRI procedure;
- the MRI unit may affect the accuracy of the oximetry measurements; and
- the MRI unit may potentially cause burns due to induced current.

Refer to your hospital’s protocols for specific instructions.
Masimo SET-Based Pulse Oximetry

Masimo SET-based pulse oximetry assumes that some of the blood flows through arterio-venous shunts rather than entirely through the capillary bed. This shunting is highly variable, and the fluctuating absorbance by venous blood is the major component of noise during the pulse.

Masimo SET pulse oximeters assume that the signals measured at the two wavelengths consist of both an arterial component and a noise component. The Masimo SET algorithm removes the noise component before calculating the functional oxygen saturation that the monitor displays.

Warnings and Cautions

This chapter includes warnings and cautions specifically related to SpO₂. Refer to Warnings and Cautions on page 23-5 in the Product Specifications chapter for cautionary disclosures that apply to electrodes and lead wires, defibrillators (including automatic implantable cardiac defibrillators), pacemakers, electrosurgical activity, several physiological parameters, or to the monitoring system itself.

Warning:

• A pulse oximeter should be considered an early warning device and should NOT be used as an apnea monitor. If a trend toward patient deoxygenation is indicated, blood samples should be analyzed by a laboratory co-oximeter to completely understand the patient's condition.

• Sensors have no adverse effect on tissues when used according to the directions for use provided by the sensor manufacturer.

• Applying an oximetry sensor incorrectly or leaving the sensor in place for too long may cause tissue damage, especially when monitoring neonates.

• Check the sensor site frequently, and do not allow the sensor to remain on one site for too long. Refer to the instructions from the sensor manufacturer for more information.

• Do not use a sensor with exposed optical components.

Caution:

• Use only patient sensors specified by Spacelabs Healthcare. If you use sensors other than those specified, it may degrade SpO₂ performance and could damage the monitor during defibrillation.

• Spacelabs Healthcare recommends the use of sensors repaired or remanufactured by the original manufacturer only.

• Never attach an SpO₂ sensor to a limb being monitored with a blood pressure cuff or a limb with restricted blood flow.

• A poorly applied sensor may give incorrect saturation values. The Sensorwatch signal-strength indicator is used to identify a poorly applied sensor or a poorly chosen site. Refer to Using the Sensorwatch Feature on page 17-12 for additional information.

• Choose a site with sufficient perfusion to ensure accurate oximetry values.
• An adapter cable is required between the sensor and the module. Do not discard the adapter cable when you have finished using a disposable oximetry sensor. Disconnect the sensor cable from the adapter cable before discarding the sensor.

Setting Up SpO₂ Monitoring

To display SpO₂ on the monitor, connect a compatible SpO₂ adapter cable to the module or telemetry transmitter. Note that module connectors are color-coded for ease of use. Attach the sensor to the patient before connecting the sensor cable to the adapter cable.

One of the two SpO₂ cable interconnection points normally involves a keyed latching mechanism.

Note:
• For telemetry products, the latch is on the transmitter end of the adapter cable.
• For non-telemetry products, the latch (if present) is on the adapter cable end of the sensor cable.

To connect two cables with this type of keyed latching mechanism:
1. Align one connector’s notch with the other connector’s keyed latch.
2. Push the connector with the notch into the connector with the keyed latch.

To disconnect these cables, release the latch and pull one cable straight out of the other.

To connect an SpO₂ adapter cable to a module:
1. Align the notch on the adapter cable’s connector with the front of the module.
2. Push the cable straight into the connector.

To remove the cable, pull the cable straight out of the module’s connector.

To set up SpO₂ monitoring:
• Connect the SpO₂ adapter cable to the module or to the patient-worn telemetry transmitter.
• Attach the sensor to the patient and connect the sensor cable to the SpO₂ adapter cable.
• Touch SPO2 (non-telemetry only).

For telemetry monitoring:
• Initiate ECG monitoring.
• Touch ECG.
• Touch CHANNEL FORMAT.
• Touch SPO2 / ON.
Ensuring Accurate SpO\textsubscript{2} Monitoring

Each sensor requires site-specific application procedures. The quality of the patient’s pulse oximetry measurements and pulse signals may be adversely affected by certain environmental factors, by oximetry sensor application errors, and by patient conditions. Any of these factors can interfere with the monitor’s ability to detect and display measurements and may result in a loss-of-pulse condition. If the SpO\textsubscript{2} measurement does not seem reasonable, first check the patient’s vital signs by alternate means and then check the pulse oximeter for proper operation.

Patients with anemia and/or significant concentrations of dysfunctional hemoglobins (such as carboxyhemoglobin, methemoglobin, and sulphemoglobin) may appear to have normal saturation values while actually being hypoxic. Further assessment, using means other than pulse oximetry, is recommended for such patients.

- For anemic patients, this condition occurs because patients have decreased arterial oxygen contents.
- For patients with dysfunctional hemoglobins (that are unable to carry oxygen), this condition occurs because less functional hemoglobin is available to carry oxygen.

Caution:

Hemoglobin levels below 5 g/dl may prevent the monitor from providing SpO\textsubscript{2} values.

Other patient conditions that may result in inaccurate measurements or a loss-of-signal condition during operation include:

- Low perfusion
- Dark pigment
- Prolonged and/or excessive patient movement
- An arterial occlusion (blocked artery) proximal to the sensor
- Venous pulsations
- Wrapping the sensor too tightly around the patient’s digit or other extremity
- Placing the sensor on an extremity with a blood pressure cuff, arterial catheter, or intravascular line
- Inflating a blood pressure cuff on the limb to which the sensor is attached

External factors that may adversely affect the accuracy of oximetry readings include:

- High ambient lighting
- High-frequency electrical noise, such as electrosurgical units and defibrillators
- The presence of intravascular dyes, such as indocyanine green or methylene blue, or externally applied coloring, such as nail polish or pigmented creams
- The patient has hypotension, severe vasoconstriction, severe anemia, or hypothermia
- The patient is in cardiac arrest or is in shock
Caution:
Sources of high ambient light such as direct sunlight, surgical lights (especially those with a xenon light source), bilirubin lamps, fluorescent lights, and infrared heating lamps can interfere with an SpO₂ sensor’s performance and result in inaccurate measurements. When using SpO₂ under such conditions, this interference can be reduced by covering the application site with an opaque material and by ensuring that the sensor is properly applied.

Taking the following actions may improve SpO₂ performance:

- Select an application site with unrestricted blood flow.
- Do not select a site near potential electrical interference (e.g., electronic equipment, electrosurgical units, other power cords). If possible, remove these electrical noise sources from the area.
- If artificial nails or externally applied coloring agents such as nail polish are present, select another site or remove the polish/artificial nails.
- If necessary, wipe the sensor site for 20 to 30 seconds with a 70% isopropyl alcohol pad to improve perfusion.
- Apply the sensor correctly, ensuring that the LEDs and the photo detector are properly aligned directly opposite each other, preferably on a site that minimizes the distance between the emitter and photodetector. Periodically check to ensure that the sensor remains properly positioned on the patient.
- Do not restrict blood flow when securing a sensor with tape.
- If high ambient light is affecting measurements, ensure that the sensor is properly applied and then cover the application site with an opaque material such as a blanket or towel. Failure to do this may result in inaccurate measurements.
- Maintain a minimum signal level above the Sensorwatch bar.

If patient movement presents a problem, one or more of the following may correct it:

- Verify that the sensor is properly and securely applied.
- Move the sensor to a less active site; to reduce or eliminate motion artifact, the application site should remain as immobile as possible.
- Use an adhesive sensor that tolerates some patient motion.
- Use a new sensor with fresh adhesive backing.
Display Detail

Note:
For telemetry display information, refer to the Digital Telemetry chapter of the Ultraview SL Operations Manual (P/N 070-1150-xx).

Figure 17-1 illustrates typical SpO₂ displays.

1. Pulse plethysmographic waveform
2. SPO2 parameter key
3. Sensorwatch signal strength indicator
   The shaded area (waveform index, WFI) expands up proportionally to signal strength. The horizontal line indicates minimum signal level (Spacelabs SpO₂ technology only).
   No shading (lowest waveform index) corresponds to no detected signal strength or a faulty sensor.
4. SatSeconds indicator (Nellcor OxiMax only); number indicates the current setting
5. Motion indicator (Nellcor OxiMax only)
6. SpO₂ pulse rate (the asterisk flashes when pulse is detected—on bedside monitors only)
7. NO PULSE alarm indicator; indicates if the NO PULSE alarm is enabled (Nellcor OxiMax only)
8. High and low SpO₂ alarm limits (on bedside monitor only)
9. Current SpO₂ value (percent)
Using the Sensorwatch Feature

The Sensorwatch feature provides a graphical presentation of the amplitude of the signal received from the sensor. It can be used to determine the best sensor site and application.

Changes in the bar’s shaded level signify changes in the patient’s perfusion or changes in the application of the sensor. The horizontal line in the bottom fourth of the bar is used in Spacelabs Healthcare SpO₂ technology only and represents the minimum signal level that results in accurate saturation values.

When the shading is just below this line, the message *LOW SIGNAL STRENGTH - Reposition or replace sensor* appears.

- Reposition the sensor to a different site to provide better perfusion.
- Reposition the sensor to provide better contact with the skin. Make sure the LEDs and photo detector are properly aligned.
- Replace a defective sensor.
- Wait for the patient to warm up and for the patient’s perfusion to increase.

NO PULSE Alarm Indicator (Nellcor OxiMax Technology)

When using Nellcor OxiMax technology, a NO PULSE alarm (a small heart) displays above the SpO₂ alarm limits in the full-width display zone whenever the NO PULSE alarm is enabled. If a persistent loss-of-pulse condition is detected, a *NO PULSE DETECTED* message displays in the waveform zone, and the NO PULSE alarm indicator will flash. When the NO PULSE alarm condition is indicated, always check the patient.

If the patient is stable, then check or try the following:

- Check the sensor site to determine if the sensor is applied too tightly to the patient’s digit. Reapply the sensor as necessary.
- Check if the sensor is on an extremity with a blood pressure cuff, an arterial catheter, or an intravascular (IV) line.
- Cover the site with an opaque blanket or towel if excessive ambient light, such as a bedside lamp or direct sunlight, is interfering with the measurements.
- Remove all sources of excessive electromagnetic interference that may prevent the monitor from tracking the pulse.
- Ensure that the sensor being used is appropriate for the patient being monitored.
• Check if excessive patient motion is preventing the monitor from tracking the pulse. Keep the patient still, if possible. Verify that the sensor is securely applied and replace it if necessary. If patient motion is an ongoing issue, use an alternate sensor site or a different sensor model.

**SatSeconds Display (Nellcor OxiMax technology)**

The SatSeconds indicator displays to the right of the Sensorwatch bar if the SatSeconds limit is turned ON. When the SatSeconds algorithm detects an SpO₂ value outside the alarm limit, the SatSeconds indicator “fills” clockwise. When the indicator is completely filled (the SatSeconds setting is reached), an SpO₂ high or low limit alarm begins. When the SpO₂ value returns to within the set limits, this indicator “empties” counterclockwise.

---

**Enabling and Adjusting Alarms**

**Spacelabs Healthcare and Masimo SET Technology**

Pulse oximetry alarm limits and delays are set internally based upon defined default values. Refer to *Setting Alarm Limits on page 6-7* for details on operating system alarms.

<table>
<thead>
<tr>
<th>To enable and adjust SpO₂ alarms (non-telemetry):</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch SPO2.</td>
</tr>
<tr>
<td>• Touch ALARM LIMITS.</td>
</tr>
<tr>
<td>• Touch ALARMS / ON.</td>
</tr>
<tr>
<td>• Touch HI=, LO=, ALM DELAY (if present), or MSG ALARM DELAY (if present).</td>
</tr>
<tr>
<td>• Use the arrow keys to adjust.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To enable and adjust SpO₂ alarms (telemetry):</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch ECG.</td>
</tr>
<tr>
<td>• Touch ALARM LIMITS.</td>
</tr>
<tr>
<td>• Touch SPO2 ALARM LIMITS.</td>
</tr>
<tr>
<td>• Select SPO2 ALM / ON.</td>
</tr>
<tr>
<td>• Select HI=, LO=, ALM DELAY, or MSG ALARM DELAY (if present).</td>
</tr>
<tr>
<td>• Use the arrow keys to adjust.</td>
</tr>
</tbody>
</table>

**Additional Information for Telemetry Products**

When SpO₂ alarms are enabled, a bell symbol appears immediately following the measured SpO₂ saturation percentage (%).
Nellcor OxiMax Technology

With traditional alarm management, upper and lower alarm limits are set for monitoring oxygen saturation. If a patient's SpO₂ level fluctuates near an alarm limit, frequent short SpO₂ alarms can occur.

If the Nellcor SatSeconds feature is enabled, then the alarm limit threshold must be continuously violated for a specified number of SatSeconds before an alarm occurs.

When the SpO₂ level violates a limit threshold, SatSeconds will begin to be counted, and the SatSeconds indicator begins to fill clockwise. Each second the number of percentage points that the saturation value is in violation of the threshold is added to the SatSeconds count. When the SatSeconds count meets or exceeds the SatSeconds setting, the SatSeconds indicator is completely filled, and the alarm sounds.

When the saturation value is no longer in violation of the limit, the alarm will stop and the SatSeconds indicator begins to empty. If the patient's oxygen saturation violates the limit again, then the SatSeconds indicator begins to fill again. Another alarm sounds if the indicator becomes completely filled.

Note:

If an alarm threshold is crossed three or more times in a 60-second period, an alarm is triggered, even if the SatSeconds limit has not been attained.

To enable and adjust SpO₂ alarms (Nellcor):

- Touch SPO2.
- Touch ALARM LIMITS.
- Touch ALARMS / ON.
- Touch HI=, LO=.
- Use the arrow keys to adjust.

SatSeconds Calculation Example

Figure 17-3 illustrates a low SpO₂ alarm limit setting of 90 and a SatSeconds setting of 50. The SpO₂ level starts above 90, falls to 88 (2 points) for 2 seconds, then falls to 86 for 3 seconds, and then falls to 84 for 6 seconds. The calculation of the resulting SatSeconds value (52) is shown below. This calculation delays the start of the low SpO₂ alarm until 50 SatSeconds is exceeded (approximately 10.9 seconds).

\[
\begin{align*}
2 \times 2 &= 4 \\
4 \times 3 &= 12 \\
6 \times 6 &= 36 \\
\text{Total SatSeconds} &= 52
\end{align*}
\]
Saturation levels may fluctuate rapidly rather than remain steady. The SpO₂ level may fluctuate above and below the alarm limit, re-entering the non-alarm range several times. During such fluctuations, the monitor integrates the number of SpO₂ points, both positive and negative, until either the SatSeconds limit is reached (when a new alarm begins) or the SpO₂ level returns to a normal range and remains there.

**To turn ON Nellcor SatSeconds functionality:**

- Touch SPO2.
- Touch ALARM LIMITS.
- Touch ALARMS / ON.
- Touch SatSecs.
- Use the arrow keys to adjust the SatSeconds limit.

**To enable the NOPULSE ALARM:**

- Touch SPO2.
- Touch ALARM LIMITS.
- Touch ALARMS / ON.
- Touch NO PULSE / ON.

**To disable the NOPULSE ALARM:**

- Touch SPO2.
- Touch ALARM LIMITS.
- Touch ALARMS / ON.
- Touch NO PULSE / OFF.
Data Averaging

The data averaging feature smooths the oximetry saturation value by averaging patient input values over several seconds. However, pulse oximeters based on Spacelabs Healthcare or Masimo SET technology and those based on Nellcor OxiMax technology perform data averaging differently.

Data Averaging with Spacelabs Healthcare or Masimo SET Technology

The data averaging interval is manually selected. For non-telemetry products, this is performed using the Averaging menu. For telemetry products, refer to the Ultraview Digital Telemetry Service Manual (P/N 070-0744-xx, located on CD-ROM 084-0700-xx) for setting the data averaging interval.

To specify a data averaging time:
- Touch SPO2.
- Touch SETUP.
- Touch AVERAGING.
- Use the arrow keys to adjust.

Data Averaging with Nellcor OxiMax technology

Nellcor data averaging is controlled by the RESPONSE MODE setting.

To specify a RESPONSE TIME setting:
- Touch SPO2.
- Touch SETUP.
- TOUCH RESPONSE MODE.
- Select either NORMAL or FAST.

When RESPONSE MODE is set to NORMAL, the averaging interval is six to seven seconds. When the RESPONSE MODE is set to FAST, the averaging interval is two to four seconds. The averaging interval can be automatically extended by the OxiMax algorithm during challenging measurement conditions. Such conditions include low perfusion, motion, external interference, or any combination of these conditions.
Sensitivity and FAST SAT (Masimo SET Technology)

With Masimo SET technology, selections for SENSITIVITY and whether to use Masimo FAST SAT algorithm are available.

**Sensitivity Settings**

Choices for SENSITIVITY are NORMAL, MAXIMUM, and APOD (Adaptive Probe Off Detection). The three sensitivity settings allow the clinician to adapt to the patient’s situation.

The APOD sensitivity setting uses processing algorithms to analyze the incoming signal. This setting is used to protect against erroneous pulse rate and SpO₂ readings that can occur when a sensor becomes detached from the patient.

The APOD setting is the least effective setting for measuring SpO₂ on patients with low perfusion.

The NORMAL sensitivity setting recommended for the majority of patients. This setting provides a combination of sensitivity and detached sensor detection.

MAXIMUM sensitivity is used in instances where SpO₂ measurements are the most difficult, and when the signal is the weakest (such as with the sickest patients). This setting is recommended during procedures and when clinician and patient contact is continuous.

If low perfusion and movement inhibits Masimo SET technology from determining a reading, change the sensitivity setting from APOD to MAXIMUM or NORMAL.

**To select Masimo SENSITIVITY:**

- Touch SPO2.
- Touch SETUP.
- Touch SENSITIVY.
- Select the sensitivity (NORMAL, MAXIMUM, APOD).

**FAST SAT Settings**

Selecting FAST SAT/ON enables that algorithm. Selecting FAST SAT/OFF disables the Fast SAT algorithm.

FAST SAT is automatically enabled whenever averaging is set to 2-4 or 4-6 seconds. However, the key will not indicate that the FAST SAT algorithm is ON when these averaging settings are used.

**To enable and disable the Masimo FAST SAT algorithm:**

- Touch SPO2.
- Touch SETUP.
- Touch FAST SAT/ON or FAST SAT/OFF.
Using SpO₂ with Intra-Aortic Balloon Pumps

Enable the intra-aortic balloon pump (IABP) feature if an IABP is in use. This selection is only available for Spacelabs Healthcare SpO₂ technology. With the IABP feature enabled, the SpO₂ software differentiates between true arterial pulsations and those produced by the IABP by excluding the IABP-generated pulsations from the calculation for SpO₂. The IABP feature can also be useful with patients experiencing irregular heart rhythms, by permitting the software to reject irregular pulses and provide a more accurate SpO₂ measurement.

<table>
<thead>
<tr>
<th>To use SpO₂ with a balloon pump (non-telemetry):</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch SPO2.</td>
</tr>
<tr>
<td>• Touch IABP YES.</td>
</tr>
</tbody>
</table>

**Note:**

- When the IABP feature is enabled, the pulse rate obtained from SpO₂ may not match the heart rate obtained from ECG.
- In cases of excessive patient motion or artifact, the accuracy of the SpO₂ measurement may be compromised when the IABP feature is enabled.
- When the IABP operation is selected for telemetry monitoring, the SPO2 status key in the ECG Channel Format menu indicates IABP. The Ultraview Digital Telemetry Service Manual (P/N 070-0744-xx, which is located on CD-ROM 084-0700-xx) describes how to configure the telemetry transmitter for use with an IABP.

Adjusting Tone Volume

With the pulse tone feature turned ON, you can adjust the tone volume. The pitch varies according to the SpO₂ value. The higher the oxygen saturation, the higher the pitch.

<table>
<thead>
<tr>
<th>To adjust tone volume (non-telemetry only):</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch SPO2.</td>
</tr>
<tr>
<td>• Touch SETUP.</td>
</tr>
<tr>
<td>• Touch TONE.</td>
</tr>
<tr>
<td>• Touch TONE / ON.</td>
</tr>
<tr>
<td>• Touch VOLUME ↑ or VOLUME ↓ to adjust.</td>
</tr>
</tbody>
</table>
Adjusting Waveform Size

You can adjust the waveform size for clarity. Changing the height of the displayed waveform does not affect the signal gain and is not related to the pulse amplitude.

To modify the waveform display (non-telemetry only):

• Touch SPO2.
• Touch SETUP.
• Verify WAVEFORM is ON.
• Touch SIZE.
• Touch SIZE↑ or SIZE↓ to adjust.

Viewing Pulse Rate

Non-Telemetry

Use the Pulse Rate feature to obtain and view a pulse rate derived from the saturation data. The pulse rate is displayed within the range of 30 to 250 beats per minute, ±3 beats per minute. For Nellcor OxiMax technology, the range is 20 to 300 beats per minute, ±3 beats per minute.

To enable the pulse rate display (non-telemetry):

• Touch SPO2.
• Touch PULSE RATE / ON or OFF.

Telemetry

For telemetry monitoring, the pulse rate for display is obtained directly from the acquired ECG leads or an alternate rate source. SpO₂ can be used as the alternate source if the multiparameter telemetry transmitter is set for continuous measurement. SpO₂ cannot be used as the alternate source when SpO₂ is set for episodic measurement (bedside monitors only). Refer to ECG on page 9-5 for additional information.
Suspending/Resuming SpO₂ Processing

Touch YES on the **Suspend Processing** menu to suspend analysis and to display the SpO₂ data. Touch NO to return to the **SpO₂** menu without affecting processing.

<table>
<thead>
<tr>
<th>To suspend SpO₂ processing:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch SPO₂.</td>
</tr>
<tr>
<td>• Touch SUSPEND PROCESSING.</td>
</tr>
<tr>
<td>• Touch YES.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To resume SpO₂ processing:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch SPO₂.</td>
</tr>
<tr>
<td>• Touch RESUME PROCESSING.</td>
</tr>
<tr>
<td>• Touch YES.</td>
</tr>
</tbody>
</table>

When you suspend SpO₂ processing:
- The message **SPO₂ PROCESSING SUSPENDED** appears in the SpO₂ waveform zone.
- Question marks (???) replace the SpO₂ and pulse rate values.
- The message **SPO₂ ALM OFF** replaces the alarm limits.
- The keys in the **SPO₂ Alarm Limits** menu are disabled.
- The SUSPEND PROCESSING key changes to RESUME PROCESSING.
Suspend on NIBP

Suspend on NIBP is used when the NIBP cuff and the SpO₂ sensor are on the same limb. When the SUSPEND ON NIBP key is set to YES, SpO₂ processing is suspended during NIBP measurements. By default, the SUSPEND ON NIBP key is set to OFF.

SpO₂ suspension begins when the NIBP cuff is fully inflated. When SpO₂ processing is suspended, the message PROCESSING SUSPENDED is displayed in the SpO₂ waveform zone, the waveform is removed from the screen, and alarms are terminated. SpO₂ suspension ends when the NIBP cuff is deflated. Normal SpO₂ processing is then resumed.

While SpO₂ processing is suspended, the RESUME PROCESSING key is enabled. You can touch RESUME PROCESSING at any time to manually override the suspended state and return SpO₂ to normal processing. The next time the cuff is inflated, SpO₂ will be suspended automatically (assuming that the SUSPEND ON NIBP key still is set to YES).

If the SUSPEND ON NIBP key is toggled from YES to NO while the NIBP cuff is inflated, SpO₂ processing will return to the normal processing state from the suspended processing state.

To suspend SpO₂ processing during NIBP measurement:
- Touch SPO2.
- Touch SUSPEND ON NIBP / YES.

Printing SpO₂ Waveforms

You can print SpO₂ waveforms and values. Refer to Printing on page 8-5 for additional information.

Note:
This feature is not supported in telemetry products.

To print SpO₂ waveforms:
- Touch RECORD.
- Touch the flashing SPO2 parameter key.
Status Messages

Caution:
Status messages indicate problems or conditions that may affect accurate monitoring values. Do not ignore these messages. Correct any fault before continuing.

When a status message appears, the saturation value and pulse rate immediately change to ????. An alarm may occur if your module is configured to do so. Depending on the configuration and option purchased, this alarm may not occur until after the message alarm delay time has elapsed.

Telemetry products use different text for SpO₂ status messages than non-telemetry products. Refer to Table 1 for interpretations of the telemetry messages.

Telemetry products also display status messages within the ECG display zone, therefore, the following ECG alarm messages take priority over other SpO₂ messages.

- LEADS OFF
- NOISY SIGNAL
- ECG ALARMS SUSPENDED

<table>
<thead>
<tr>
<th>SpO₂ Message</th>
<th>Equivalent Telemetry SpO₂ Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADAPTER DISCONNECTED — Check connection at module</td>
<td>SPO2 SENSOR DISCONNECTED</td>
</tr>
<tr>
<td>FAULTY SENSOR – Replace sensor</td>
<td>SPO2 FAULTY SENSOR</td>
</tr>
<tr>
<td>SENSOR DISCONNECTED — Check connection at adapter cable</td>
<td>SPO2 SENSOR DISCONNECTED</td>
</tr>
<tr>
<td>SENSOR OFF PATIENT – Check connection at patient</td>
<td>SPO2 SENSOR OFF PATIENT</td>
</tr>
<tr>
<td>INSUFFICIENT SIGNAL – Reposition or replace sensor</td>
<td>SPO2 INSUFFICIENT SIGNAL</td>
</tr>
<tr>
<td>AMBIENT LIGHT INTERFERENCE – Cover sensor area</td>
<td>SPO2 AMBIENT LIGHT INTF.</td>
</tr>
<tr>
<td>NOISY SIGNAL</td>
<td>SPO2 NOISY SIGNAL</td>
</tr>
<tr>
<td>LOW SIGNAL STRENGTH – Reposition or replace sensor</td>
<td>SPO2 INSUFFICIENT SIGNAL</td>
</tr>
</tbody>
</table>

ADAPTER DISCONNECTED — Check connection at module

- The module does not detect an adapter cable connected to the front panel. Check proper adapter cable connection.
- If the message persists and the adapter cable is secure, then replace the adapter cable.
- If the channel is removed from the display, then the alarm stops after approximately 10 seconds.
SENSOR DISCONNECTED — Check connection at adapter cable

This message and alarm indicate that the sensor is either disconnected or the wiring is faulty.

- Check for proper sensor connection to the adapter cable.
- If the message persists, replace the sensor and/or the adapter cable.

SENSOR OFF PATIENT — Check connection at patient

- The module does not detect a valid sensor input signal. Check the patient for proper sensor placement.
- The tissue between the LED and photodiode is too transmissive. If the sensor placement seems correct and the message persists, try a sensor site with a thicker tissue bed.

Note:
This message is not available with all SpO2 sensors.

INSUFFICIENT SIGNAL — Reposition or replace sensor

- Insufficient signal for proper operation, indicated by a low deflection on the Sensorwatch signal strength bar.
- Poor sensor application or site. Correctly re-apply or reposition to a better perfused site, or massage the site.
- If the message persists, then replace the sensor.

AMBIENT LIGHT INTERFERENCE — Cover sensor area

- The sensor is receiving external light interference from a bright light source near the sensor. Shield the sensor from the external light source.
- The sensor photodiode and LED are misaligned on flexible sensors, allowing light to enter. Realign the sensor photodiode with the LED.
- If the message persists, then replace the sensor.

NOISY SIGNAL

- The sensor signal is disturbed by motion or other interference. Eliminate sensor movement.
- Power cords or other electrically noisy devices are too close to the sensor. Move the noisy device or move the sensor to another site.
- If the message persists, then replace the sensor.

LOW SIGNAL STRENGTH — Reposition or replace sensor

When this message appears, the saturation and pulse rate continue to display. However, the Sensorwatch bar flashes as an indication of a possible error condition.

- Insufficient blood flow between the sensor light emitter and detector. Move the sensor to an area of higher perfusion.
- Poor sensor application. Reposition to place active components closer to the skin or locate to a better perfused site.
• The sensor site is below the blood pressure cuff. Move to another site.
• If the message persists, then replace the sensor.

**HARDWARE INCOMPATIBILITY — Contact service**

The hardware configuration in your module is not compatible with the programmed software options.
• Contact your Spacelabs Healthcare Field Service Engineer.

**FAULTY SENSOR — Replace sensor**

• The LED or photodiode (or both) may have failed.
• Ensure the sensor is properly connected, disconnect and then reconnect the sensor.
• If the error occurs again, replace the sensor and/or sensor adapter cable.
• If replacing the sensor and/or cable does not correct the problem, contact your Spacelabs Healthcare Field Service Engineer.

---

**Status Messages — Nellcor OxiMax Technology**

**FAULTY SENSOR — OxiMax Sensors Only**

This message displays if a sensor other than a Nellcor OxiMax sensor is used. It may also appear if a defective OxiMax sensor is used.

• To clear this message, apply a functional Nellcor OxiMax sensor. Note that this message does not clear when the faulty sensor is removed, but only when a valid sensor is applied.

**OXYMETER FAILURE — Error XXX**

XXX is a numeric error code. This message is displayed if the oximeter has experienced a fatal error and is attempting to restart. If the oximeter is successfully restarted, the message clears and normal operation is restored.

If the oximeter cannot be restarted, then Contact Service will be appended to the end of the message. If the oximeter fails at power-ON, then the SPO2 channel appears on the display with the error message.

• If the Contact Service portion of the message is not displayed, the system is attempting to restart the oximeter. Wait one minute to see if the oximeter restarts.
• When the Contact Service portion of the message is displayed, remove the module and reinsert. This may restore functionality.
• If reinserting the module does not clear the error, contact your Spacelabs Healthcare Field Service Engineer.
NO PULSE DETECTED

This message is displayed under the following circumstances:

- the NO PULSE alarm is enabled;
- the sensor appears to be connected and on the patient;
- the oximeter cannot find a pulse signal.

When this message displays:

- Follow the instructions under NO PULSE Alarm Indicator (Nellcor OxiMax Technology) on page 17-12 to restore the pulse signal.

INSUFFICIENT SIGNAL

This message displays if the signal received by is inadequate to process \( \text{SpO}_2 \). The sensor may be applied incorrectly, or there may be signal interference. When an INSUFFICIENT SIGNAL message displays, an additional message will display on the line below and will identify possible causes and solutions.

Possible Causes

- Sensor off
- Weak pulse
- Weak signal
- Motion interference
- Excess infrared light
- Electrical or optical interference
- High pulse amplitude

Suggested Solutions

- Alternate site
- Cover sensor site
- Ear or forehead sensor
- Nasal or ear sensor
- OxiMax adhesive sensor
- Secure cable
- Headband
- Warm site
- Bandage assembly
- Nail polish
- Sensor too tight
- Reposition sensor
- Isolate interference source
- Clean sensor site
Status Messages — Masimo SET Technology

FAULTY OXIMETER — Contact Service

If the module’s Masimo SET technology fails, a FAULTY OXIMETER message displays. If the oximeter cannot be restarted, then Contact Service will be appended to the end of the message.

- If the Contact Service portion of the message is not displayed, the system is attempting to restart the oximeter. Wait one minute to see if the oximeter restarts.
- When the Contact Service portion of the message is displayed, remove the module and then reinsert. This may restore functionality.
- If reinserting the module does not clear the error, contact your Spacelabs Healthcare Field Service Engineer.

LOW PERFUSION

This message displays if a low perfusion condition is detected.

LOW SIGNAL STRENGTH — Reposition or replace sensor

This message displays if there is an insufficient signal. If a saturation value does not display with this message, then an alarm occurs.

INTERFERENCE DETECTED — Check sensor and cables

This message occurs when interference other than light interference is detected.

Sensors

For SpO2 sensor compatibility, refer to the following information.

Spacelabs Healthcare SpO2 Sensors

Adapter cable 700-0030-01 is required for the 90496 and 91496 modules; adapter cable P/N 700-0014-00 is required for 90343-05 transmitters. Please refer to the Spacelabs Healthcare Supplies & Accessories Catalog (P/N 084-1201-xx) for compatible sensors and adapter cables.
Nellcor OxiMax SpO₂ (91496-N) Sensor Compatibility

Adapter cable P/N 700-0792-00 is required. Please refer to the Spacelabs Healthcare Supplies & Accessories Catalog (P/N 084-1201-xx). The following sensor lines are compatible with 91496-N:

Table 2: Nellcor sensors compatible with 91496-N

<table>
<thead>
<tr>
<th>OxiMax Sensors (single-patient use)</th>
<th>OxiCliq Sensors (single-patient use)</th>
<th>Reusable Sensors</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX-A, MAX-AL</td>
<td>OxiCliq A</td>
<td>D-YS</td>
</tr>
<tr>
<td>MAX-N</td>
<td>OxiCliq P</td>
<td>D-YS, D-YSE</td>
</tr>
<tr>
<td>MAX-P</td>
<td>OxiCliq N</td>
<td>D-YS, D-YSPD</td>
</tr>
<tr>
<td>MAX-I</td>
<td>OxiCliq I</td>
<td>DS-100A</td>
</tr>
<tr>
<td>MAX-FAST</td>
<td></td>
<td>OXI-A/N</td>
</tr>
<tr>
<td>MAX-R</td>
<td></td>
<td>OXI-P/I</td>
</tr>
</tbody>
</table>

Masimo SET SpO₂ (91496-M) Sensor Compatibility

Adapter cable P/N 700-0789-00 is required. Please refer to the Spacelabs Healthcare Supplies & Accessories Catalog (P/N 084-1201-xx). The entire family of LNOP sensors is supported.

Additional Information

For additional information about biocompatibility or sensor disposal, refer to the manufacturer's instructions enclosed with each sensor.
## SpO₂ Troubleshooting Guide

<table>
<thead>
<tr>
<th>Clinical Situation</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No SpO₂ parameter key is displayed</strong></td>
<td>■ Module is not inserted correctly.</td>
<td>■ Remove and reinsert the module.</td>
</tr>
<tr>
<td></td>
<td>■ Adapter cable is improperly connected to the module.</td>
<td>■ Correctly connect the adapter cable.</td>
</tr>
<tr>
<td></td>
<td>■ Sensor is not connected to the adapter cable.</td>
<td>■ Correctly connect the sensor.</td>
</tr>
<tr>
<td></td>
<td>■ SpO₂ is not enabled at the 90343 transmitter.</td>
<td>■ Contact your biomed or a qualified field service engineer to check the DIP switches 1 and 2 on the transmitter.</td>
</tr>
<tr>
<td></td>
<td>■ SpO₂ is not enabled at the 90478 receiver.</td>
<td>■ Enable multiparameter telemetry in the Module Configuration Manager or enable the SpO₂ display in the <strong>Channel Format</strong> menu.</td>
</tr>
<tr>
<td><strong>SpO₂ value displays as ??</strong></td>
<td>■ Sensor is not connected to the patient.</td>
<td>■ Reattach the sensor.</td>
</tr>
<tr>
<td></td>
<td>■ There is excessive patient motion.</td>
<td>■ Request patient to remain still while reading is in progress.</td>
</tr>
<tr>
<td></td>
<td>■ Module is in the initialization phase (the first 15 seconds after sensor application).</td>
<td>■ Wait until the initialization is complete.</td>
</tr>
<tr>
<td></td>
<td>■ Adapter cable is improperly connected to the module.</td>
<td>■ Correctly connect the adapter cable.</td>
</tr>
<tr>
<td></td>
<td>■ Sensor is not connected to the adapter cable.</td>
<td>■ Correctly connect the sensor.</td>
</tr>
<tr>
<td></td>
<td>■ Telemetry low battery indicator is constantly illuminated.</td>
<td>■ Contact your biomed or a qualified field service engineer.</td>
</tr>
<tr>
<td>Clinical Situation</td>
<td>Possible Cause</td>
<td>Solution</td>
</tr>
<tr>
<td>--------------------</td>
<td>----------------</td>
<td>----------</td>
</tr>
<tr>
<td>Low signal strength</td>
<td>Sensor placement is not optimum.</td>
<td>Move the sensor to a site which has better perfusion.</td>
</tr>
<tr>
<td></td>
<td>Sensor is placed below the blood pressure cuff.</td>
<td>Align the LED with the sensor photo detector.</td>
</tr>
<tr>
<td></td>
<td>Move the sensor to an alternate limb.</td>
<td></td>
</tr>
<tr>
<td>Intermittent or complete failure to operate</td>
<td>Module error.</td>
<td>Contact your biomed or a qualified field service engineer.</td>
</tr>
<tr>
<td>Factors causing significant variances in sensor accuracy</td>
<td>Presence of dysfunctional hemoglobins (COHb, MetHb).</td>
<td>Follow hospital procedure for determining oxygenation in these patients.</td>
</tr>
<tr>
<td></td>
<td>Presence of intravascular dyes (indocyanine green, methylene blue) in the blood stream.</td>
<td>Follow hospital procedure for determining oxygenation in these patients.</td>
</tr>
<tr>
<td></td>
<td>High ambient light level.</td>
<td>Reduce light levels near the patient.</td>
</tr>
<tr>
<td></td>
<td>Electrosurgical interference.</td>
<td>Follow hospital procedure for determining oxygenation in these patients.</td>
</tr>
<tr>
<td></td>
<td>Patient is significantly anemic (Hb less than 5 g/dl) or has received large amounts of IV solutions.</td>
<td>Follow hospital procedure for determining oxygenation in these patients.</td>
</tr>
<tr>
<td>No SpO2 alarms are displayed (telemetry only)</td>
<td>ECG “Leads Off” condition exists.</td>
<td>Re-attach ECG lead wires to the patient and resume ECG monitoring.</td>
</tr>
<tr>
<td></td>
<td>Higher priority alarm condition is present.</td>
<td>Clear the current alarm condition and/or re-prioritize SpO2 alarms in the Module Configuration Manager.</td>
</tr>
<tr>
<td></td>
<td>When SpO2 alarms are ON, all SpO2 alarm conditions cause the parameter value to blink according to the alarm priority set using the Module Configuration Manager.</td>
<td></td>
</tr>
</tbody>
</table>
### SpO₂

<table>
<thead>
<tr>
<th>Clinical Situation</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAULTY SENSOR Replace Sensor (OxiMax sensors only)</td>
<td>■ A faulty or incompatible sensor is connected to the adapter cable.</td>
<td>■ To clear the message, connect a known good Nellcor OxiMax sensor to the adapter cable, or unplug the module.</td>
</tr>
<tr>
<td></td>
<td>■ Sensor has failed.</td>
<td></td>
</tr>
</tbody>
</table>
Temperature

Directory of Keys

- **TEMP**
- **TEMP MENU**
- **ALARM LIMITS** (Key may not display)
- **RESTORE SETTINGS** (Key may not display)

**TEMP - ALARM LIMITS**

<table>
<thead>
<tr>
<th>ALARMS</th>
<th>HI = XXX</th>
<th>LO = XXX</th>
<th>↑</th>
<th>↓</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OFF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Keys will display if two probes are used.

<table>
<thead>
<tr>
<th>ALARMS</th>
<th>HI = XXX</th>
<th>LO = XXX</th>
<th>↑</th>
<th>↓</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OFF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Keys will display if four probes are used and second TEMP key is selected.

- **TEMP 1**
- **TEMP 2**
- **DELTA TEMP**
- **SITE LABEL**

Alternate Key display

- **ALARMS**
- **HI = XXX**
- **LO = XXX**
- **↑**
- **↓**

Select Temp Sensor locations. Press SAVE to accept current selection.

- **T1/TEMP 1**
- **T2/TEMP 2**
- **↑**
- **↓**
- **SAVE**
Temperature

Contents

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Setting Up Temperature Monitoring ............................. 3
Display Detail ......................................................... 4
Enabling and Adjusting Alarms .................................. 4
Printing Temperature Readings .................................. 5

Overview

You can monitor up to four temperature inputs. When two temperatures from the same module are being monitored, a delta value (temperature difference between the two readings) is calculated.

Note:

• Temperatures are displayed in degrees centigrade only. You can set independent high and low alarm limits for each temperature, and for the delta temperature.

• To define your own default parameter settings and alarm settings, refer to the Ultraview SL Module Configuration Manager System Administration Guide (P/N 070-1245-xx).

Setting Up Temperature Monitoring

Attach the temperature probe(s) to the patient and then to the module. The TEMP key and temperature values appear on the monitor display. Touch TEMP to display the Temperature menu.

To set up temperature monitoring:

• Attach the temperature probe(s) to the patient.
• Plug the temperature probe(s) into the module.
• Touch TEMP.
• Select additional keys as needed during monitoring.
Temperature

Display Detail

Temperature readings appear on the monitor display as soon as you plug a temperature probe into the module.

![Figure 18-1: Temperature display](image)

1. TEMP parameter key
2. Single channel temperature reading
3. Temperature label
4. Two temperatures (T1/T2 or T3/T4)
5. Delta temperature (DT)
6. Status of temperature alarms

**Note:**
When alarm limits are set on more than one temperature, individual alarm limits are replaced by alarm ON/OFF status indicators.

Enabling and Adjusting Alarms

High and low alarm limits can be set for T1 (T3), T2 (T4), and for the difference between two temperatures (DT). Refer to Setting Alarm Limits on page 6-7 for details on operating system alarms.

**To enable and adjust alarms:**
- Touch TEMP.
- Touch ALARM LIMITS.
- Select TEMP 1, TEMP 2, TEMP 3, TEMP 4, or DELTA TEMP.
- Select ALARMS / ON.
- Select HI= or LO=.
- Use the arrow keys to adjust.
Setting Temperature Sensor Site Labels

You can select a site label that indicates the location of the temperature sensor by using the Site Label menu. Touch the SITE LABEL key to access this menu. Then select which temperature probe you wish to label (T1 or T2). Press the up or down arrow until the appropriate site label is displayed in the key. Site label selections will not take effect until the SAVE key is touched. Site labels will display onscreen and in trends.

Available selections for site labels are esophageal (esoph), rectal (rect), skin, bladder (blad), tympanic (tymp), axillary (axil), pulmonary artery (pa), central venous (cv), blood, (blood) myocardial (myo), nasopharyngeal (naso), and core (core).

To select a temperature sensor site label:
- Touch TEMP.
- Touch SITE LABEL.
- Select T1/TEMP 1 or T2/TEMP 2.
- Use the arrow keys to select the site label.
- Touch SAVE.

Printing Temperature Readings

You can send currently displayed temperature readings to a bedside or system printer. Refer to Printing on page 8-5 for system printing information.

To print current temperature readings:
- Touch RECORD.
- Touch TEMP while it flashes.
# Temperature Troubleshooting Guide

<table>
<thead>
<tr>
<th>Clinical Situation</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermittent or no operation</td>
<td>Module error.</td>
<td>Contact your biomed or a qualified field service engineer.</td>
</tr>
<tr>
<td>Temperature not displayed</td>
<td>Module is not inserted correctly.</td>
<td>Reinsert the module.</td>
</tr>
<tr>
<td></td>
<td>Probe is not connected to module.</td>
<td>Reconnect the probe.</td>
</tr>
</tbody>
</table>
Calculations

Directory of Keys

Refer to Introduction
Trends/Calcs must be enabled
Refer to Alarms
Refer to Printing
Refer to Introduction

SPECIAL FUNCTIONS

LOCAL TRENDS/CALCS

TRENDS/CALCS for BED xxx

CALCS
Refer to page 19-2

DRUG CALCS
Refer to page 19-3
Clinical Calculations

TRENDS/CALCS for BED xxx

<table>
<thead>
<tr>
<th>CALCS</th>
<th>DRUG CALCS</th>
</tr>
</thead>
</table>

Refer to page 19-3

CLINICAL CALCS for BED xxx

| HEMO CALCS | RESP CALCS | OXY CALCS | RENAL CALCS | UPDATE DATA |

X CALCS - Select a menu key

| NEW ENTRY | EDIT INPUTS | EDIT DAY/TIME | STORE ENTRY | DELETE ENTRY | PAGE SCROLL | ← | → | PRINT |

HEMO CALCS EDIT INPUTS MENU - Select input to change

| HR bts/min | MAP mmHg | CVP mmHg | MPA mmHg | PCWP mmHg | BSA m2 | CO L/min |

RESP CALCS EDIT INPUTS MENU - Select input to change

| RR br/min | PaCO2 mmHg | VT ml/br | PIP cmH2O | PLT cmH2O | PEEP cmH2O | PECO2 mmHg |

OXY CALCS EDIT INPUTS MENU - Select input to change

| FIO2 % | PaO2 mmHg | SpO2 % | PaCO2 mmHg | PVO2 mmHg | SvO2 % | Hgb g/dl | PB mmHg | CO l/min | BSA m2 |

RENAL CALCS EDIT INPUTS MENU - Select input to change

| URK mEq/L | PLOSM mOsm/L | UROSM mOsm/L | SerNa mEq/L | CR mg/dl | UCR mg/dl | BUN mg/dl | UREA mEq/L | URINE ml/day | BSA m2 |
Drug Dosage Calculations

TRENDS/CALCS for BED xxx

Refer to page 19-2

ADULT DRUG DOSAGE - Select a drug or menu key

Refer to page 19-4

ADULT TITRATION TABLE - Select dose type

Neonate only

ADULT DRUG DOSAGE - Select dose type

Dose/min mcg/min
Dose/hr mcg/hr
Dose/WT/min mcg/kg/min
Dose/WT/hr mcg/kg/hr
Drug Dosage Calculations (continued)

(Refer to page 19-3)

EDIT INPUTS MENU - Select input to change

<table>
<thead>
<tr>
<th>DRUG</th>
<th>UNITS</th>
<th>AMT</th>
<th>VOL</th>
<th>CONC</th>
<th>WEIGHT</th>
<th>DOSE</th>
<th>RATE</th>
<th>DUR</th>
<th>TOTAL DOSE</th>
<th>TOTAL VOL</th>
</tr>
</thead>
</table>

ADULT DRUG DOSAGE - Select dose type

- DOSE/MIN mgcg/min
- DOSE/HR mgcg/hr
- DOSE/WT/MIN mgcg/kg/min
- DOSE/WT/HR mgcg/kg/hr

Select units

<table>
<thead>
<tr>
<th>AMOUNT</th>
<th>DOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>mcg</td>
<td>mg</td>
</tr>
<tr>
<td>g</td>
<td>mEq</td>
</tr>
<tr>
<td>units</td>
<td>k units</td>
</tr>
<tr>
<td>m units</td>
<td></td>
</tr>
</tbody>
</table>

DRUG NAME LIST

Select name for DRUG A:

<table>
<thead>
<tr>
<th>Aminophylline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bretylium</td>
</tr>
</tbody>
</table>

ACCEPT  CANCEL
Calculations

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Editing Day and Time .................................................. 11
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Overview

The Calculations feature can be divided into two types:

- Clinical or Physiologic (refer to Display Detail — Physiologic Calculations on page 19-6)
- Drug Dosage (refer to Setting Up Drug Dosage Calculations on page 19-19)

Physiologic calculations include hemodynamic, respiration, oxygenation, and renal. These calculations use input values entered manually, or collected automatically by the system, to produce a set of output values.

Drug Dosage calculations enable you to determine infusion rates for drugs, based on drug concentration, desired dose, patient weight, and patient type (adult or neonate).

The UPDATE DATA key is used to synchronize calculation data between multiple monitors. For example, if lab data for calculations were entered at the central monitor and stored in the bedside monitor database, using the UPDATE DATA key would provide those values for calculations performed at the bedside.
Calculations

Accessing Calculation Data

Calculations can be accessed via the local bedside monitor or from a remote monitor on the network, depending upon the options purchased. Contact your system administrator for details if you are unable to access this function. The data displayed in the Calculations table is from the selected monitor.

Values are entered into the system in several ways. You can take a snapshot of currently monitored inputs by selecting the NEW ENTRY key (refer to Creating a New Entry on page 19-8). You can also specify a day and time to gather input data from the past, although this function is generally limited to the past 24 hours.

**Note:**

*If the monitor is turned OFF, all calculations data will be lost.*

---

To access physiologic or drug dosage calcs:

- Touch SPECIAL FUNCTIONS.
- Touch LOCAL TRENDS/CALCS or REMOTE TRENDS/CALCS.
- If you selected REMOTE TRENDS/CALCS, then select a bed.
- Touch CALCS or DRUG CALCS.

---

Display Detail — Physiologic Calculations

The system displays a combined total of 200 entries into the four physiologic calculations tables:

- Hemodynamic (refer to Hemodynamic Calculations on page 19-13)
- Respiration (refer to Respiration Calculations on page 19-15)
- Oxygenation (refer to Oxygenation Calculations on page 19-16)
- Renal (refer to Renal Calculations on page 19-18)

Each table has an **Edit Inputs Menu** to edit the input data. You can also create a record of both input and output data by printing the displayed table.

Tables for physiologic calculations occupy several display zones above the message line, allowing waveforms to appear on the remaining zones of the display.

Seven columns of data (records) can be displayed on the display at one time. The date, hour, and minute displayed in the day/time key at the top of the column indicate when that record’s information (which is displayed below the key) was acquired. Hours can be displayed in either a 12-hour or 24-hour format, depending on the system setup. An A (for a.m.) or a P (for p.m.) follows the minute value when you use the 12-hour format.

The table's dividing line separates a record's calculation inputs from its calculated outputs. The calculation inputs above the dividing line were automatically collected or manually entered. The calculated output values are displayed below the dividing line.
Calculations

Figure 19-1: Physiologic calculations table (Hemodynamics)

1. The top line of the table shows the type of calculations performed, the bed name, patient name, and date.
2. A day/time key is displayed at the top of each data column. It indicates the day, hour, and minute of the data.
3. Calculation inputs
4. Dividing line
5. Calculated outputs
6. Selected record

Note:

All keys appear disabled, except for NEW ENTRY and PRINT, until at least one record is displayed in the table.

Scrolling and Paging

Within the table, older records appear to the left and newer records appear to the right. Records created using NEW ENTRY appear to the right of the existing records. If the table is full, older records shift left one column so the new record can be displayed. Older records that are shifted off the display remain in memory and can be displayed by paging or scrolling.

Toggle the PAGE/SCROLL key to SCROLL, and use the arrow keys to move the Calculations table one column in the selected direction. Toggle the PAGE/SCROLL key to PAGE and use the arrow keys to move the table one page (seven columns) in the selected direction.

Touch the right arrow key to view the next newer column or page of data (the key is disabled when the newest record is displayed in the table). Touch the left arrow key to view the next older column or page of data (the key is disabled when the oldest record is displayed in the table).
Calculations

Creating a New Entry

Touch the NEW ENTRY key to create a new record for the current day and time in the Calculations table, immediately to the right of existing records. The new record’s day/time key is highlighted and contains the current day and time. Any available input values and calculated output values are displayed in this column. Any unavailable inputs or outputs are displayed as question marks.

NEW ENTRY is disabled when a total of 200 records exists in all the Physiologic calculations tables for the selected monitor. If you want to make further entries, you must first delete some of the existing entries from one or more of the calculations tables.

Note:

*After creating a NEW ENTRY, touch STORE ENTRY to store the entry in the database. Entries that have not been stored remain in the table until you select a different bed or patient; then they disappear.*

To view calculations data:

- Touch CALCS.
- Select a calcs key.
- Toggle the PAGE/SCROLL key to SCROLL and use the ← and → keys to move data by one column.
  - OR-
- Toggle the PAGE/SCROLL key to PAGE and use the ← and → keys to move data by seven columns.

To create a new entry/record:

- Access Local or Remote Calcs.
- Touch CALCS.
- Select a Calcs key.
- Touch NEW ENTRY.
- Touch EDIT INPUTS to input new data not available in the system.
- Select an input key.
- Use the on-screen keypad to input the value.
- Touch ENTER on the on-screen keypad.
- Touch PREVIOUS MENU.
- Touch STORE ENTRY to retain entry in Calcs table.
Calculations

Editing Inputs

The Edit Inputs menu for each type of calculation contains keys for the inputs listed in the table. Each input’s name and unit of measurement appear in these keys. Once an input has been edited, the letter e appears immediately after the edited value in the table.

Note:
- The displayed units for pressure values, height, and weight may vary based on your monitor’s configuration. Contact your system administrator for details.
- Changing the height and weight in the BSA menu does not affect the height and weight in the Admit/Discharge menu.

When you select an input key, the on-screen keypad appears with that parameter label and value displayed at the top (refer to Figure 19-2). The value displayed is the selected item’s current value from the table, if available. An input’s default value appears if that value is unknown or if the value available from the system when that record was created/read is over or under the acceptable range.

Use the numeric digit keys to enter or edit the selected input value, or use the arrow keys to increase or decrease the value. Up to seven digits (including a decimal point and any undisplayed digits to its right), based on the assigned field size, can be entered at a time. You must touch the ENTER key on the keypad to save the edits and display the data in the calculations table.

![Figure 19-2: On-screen keypad](image)

1. Input label
2. Input value
Calculations

*Table 1* describes the use of the remaining keys on the keypad

<table>
<thead>
<tr>
<th>Touch</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>REMOVE KEYPAD</td>
<td>Closes the keypad and discards any changes made.</td>
</tr>
<tr>
<td>CLEAR</td>
<td>Sets the value displayed above the keypad to 0.</td>
</tr>
<tr>
<td>RESTORE</td>
<td>Redisplays the value from the table above the keypad.</td>
</tr>
<tr>
<td>±</td>
<td>Toggles the sign of the value displayed (disabled if the value cannot be negative).</td>
</tr>
</tbody>
</table>
| ENTER             | Saves the displayed value after verifying the input value is within its valid range:  
|                   |   • If the value is within its valid range, the keypad closes and the value is transferred to the table. Other values affected by this input value are recalculated and redisplayed, but not stored.  
|                   |   • If the value is outside its valid range, the monitor sounds a single error tone and displays an error message for 10 seconds. The entered input value remains above the keypad and can be cleared by touching RESTORE, CLEAR, or any number key. |

To edit a record:

- Access Local or Remote Calcs.
- Touch EDIT INPUTS.
- Select an input value to edit.
- Use the on-screen keypad to change the input value.
- Touch ENTER on the on-screen keypad.
- Touch PREVIOUS MENU then touch STORE ENTRY to retain the entry in the Calcs table.

If you enter a height and weight in the BSA menu, the system automatically computes a BSA. However, changing the BSA directly invalidates any height or weight previously entered. Refer to *Table 2* for BSA, height, and weight values for hemodynamics, oxygenation, and renal calculations.
Calculations

Table 2: BSA, Height, and Weight Calculations

<table>
<thead>
<tr>
<th>Label</th>
<th>Name</th>
<th>Units</th>
<th>Valid Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSA</td>
<td>Body Surface Area</td>
<td>m²</td>
<td>0.03 to 3.69</td>
</tr>
<tr>
<td>HT</td>
<td>Height</td>
<td>cm, in</td>
<td>20 to 215 7.9 to 84.6</td>
</tr>
<tr>
<td>WT</td>
<td>Weight</td>
<td>kg, lb</td>
<td>0.2 to 250.0 0.441 to 551.156</td>
</tr>
</tbody>
</table>

\[
\text{BSA} = Ht^{0.725} \times Wt^{0.425} \times 0.007184
\]

Editing Day and Time

To create a calculations record for a specified day and time, create a new entry and highlight the day/time key at the top of the appropriate column. Touch EDIT DAY/TIME and enter the day and time for the record you want to create (you cannot change the value to a future time). Touch the DAY, HOUR, or MINUTE keys to highlight that key and display the on-screen keypad (refer to Figure 19-2 on page 19-9). After you enter the day, hour, and minute, the input values and output calculations reflect data available from the system at the entered time. An e appears under any edited day/time key.

To create a record for a past time:

- Access Local or Remote Calcs.
- Touch NEW ENTRY.
- Highlight a day/time key on a new or prior entry.
- Touch EDIT DAY/TIME.
- Select DAY, HOURS, or MINUTES.
- Use the on-screen keypad to change.
- Touch ENTER on the on-screen keypad.
- Touch PREVIOUS MENU, then STORE ENTRY to retain the entry in the Calcs table.

Since the hour can appear in either 12-hour or 24-hour format, use the AM/PM key to select a.m. and p.m. on the DAY/TIME key if the system is set for 12-hour format.
Storing and Deleting an Entry

After selecting a day/time key, you can store that record by touching STORE ENTRY, or you can delete that record by touching DELETE ENTRY. A menu appears to confirm the deletion. Up to 100 stored records may be saved in each system. Deleting a record simultaneously deletes that record from the database if it was previously stored in the database via the STORE ENTRY key. Storing a record overwrites any data that was previously stored in the database for that record.

The letter s appears under the day/time key to indicate that the record is stored. If you edit a record after it is stored, the letter s is removed because the newly edited changes are not stored.

Note:

- Stored records are saved until the monitor is powered OFF or until patient data is purged via the Admit/Discharge function (refer to Discharging a Patient on page 7-7).

- Automatically displayed records, such as cardiac output data, remain in the database. These records reappear, even if deleted, when you leave and then return to a patient or bed.

- Records that are not stored will not be available on Remote Calcs or when Calcs is accessed again on the local monitor.

<table>
<thead>
<tr>
<th>To store an entry:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Access Local or Remote Calcs.</td>
</tr>
<tr>
<td>• Highlight the day/time key of the entry to be stored.</td>
</tr>
<tr>
<td>• Touch STORE ENTRY.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To delete an entry:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Access Local or Remote Calcs.</td>
</tr>
<tr>
<td>• Highlight the day/time key of the entry to be deleted.</td>
</tr>
<tr>
<td>• Touch DELETE ENTRY.</td>
</tr>
<tr>
<td>• Touch YES.</td>
</tr>
</tbody>
</table>
Hemodynamic Calculations

Hemodynamic calculations provide data describing cardiovascular system performance. Cardiac output values from a Cardiac Output (CO) module automatically create records in the Hemodynamic Calculations table.

When you create a new entry, the day/time key displays the current time and any current values for HR, MAP, CVP, MPA, PCWP, and body surface area are automatically displayed in the table. The most recent CO value (if less than 15 minutes old) is also put into the table. If the system locates a CO value, then values for MAP, CVP, MPA, or PCWP not currently available are put into the table from the CO record. Any inputs that remain unavailable appear as question marks. Refer to Table 2 for BSA values.

To view current hemodynamic calculations:
- Access Local or Remote Calcs.
- Touch HEMO CALCS.

When a substitution occurs, one of the following error messages appears on the message line.

- **Warning...RAP has been substituted for CVP.**
  A continuous RAP value is used instead of the continuous CVP value if CVP is not available.

- **Warning...NIBP has been substituted for MAP.**
  An episodic mean NIBP value that is less than 15 minutes old is used instead of MAP if the continuous MAP value is not available.

<table>
<thead>
<tr>
<th>Label</th>
<th>Name</th>
<th>Units</th>
<th>Default Value</th>
<th>Valid Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR</td>
<td>Heart Rate</td>
<td>bpm</td>
<td>70</td>
<td>0 to 300</td>
</tr>
<tr>
<td>MAP</td>
<td>Mean Arterial Pressure</td>
<td>mmHg</td>
<td>80</td>
<td>-50 to 300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>kPa</td>
<td>10.7</td>
<td>6.7 to 40</td>
</tr>
<tr>
<td>CVP</td>
<td>Central Venous Pressure</td>
<td>mmHg</td>
<td>10</td>
<td>-50 to 99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>kPa</td>
<td>1.3</td>
<td>-6.7 to 15</td>
</tr>
<tr>
<td>MPA</td>
<td>Mean Pulmonary Artery Pressure</td>
<td>mmHg</td>
<td>15</td>
<td>-50 to 99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>kPa</td>
<td>2.0</td>
<td>-6.7 to 15</td>
</tr>
<tr>
<td>PCWP</td>
<td>Pulmonary Capillary Wedge Pressure</td>
<td>mmHg</td>
<td>10</td>
<td>-50 to 99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>kPa</td>
<td>1.3</td>
<td>-6.7 to 15</td>
</tr>
<tr>
<td>CO</td>
<td>Cardiac Output</td>
<td>L/min</td>
<td>5</td>
<td>0 to 40</td>
</tr>
</tbody>
</table>

Hemodynamic Calculations require specific pressure values, including CVP, MAP, and PCWP. CVP and MAP are monitored continuously; PCWP is an episodic value. A data substitution may occur if any of these pressure values are not available when you touch NEW ENTRY. When a substitution occurs, one of the following error messages appears on the message line.

- **Warning...RAP has been substituted for CVP.**
  A continuous RAP value is used instead of the continuous CVP value if CVP is not available.

- **Warning...NIBP has been substituted for MAP.**
  An episodic mean NIBP value that is less than 15 minutes old is used instead of MAP if the continuous MAP value is not available.
Calculations

- **Warning...LAP has been substituted for PCWP.**
  
  A continuous LAP value is used instead of the episodic PCWP value if the PCWP value is not available or is more than 15 minutes old.

### Table 4: Hemodynamic Outputs (assumes pressures are measured in mmHg)

<table>
<thead>
<tr>
<th>Variable (Label)</th>
<th>Equations</th>
<th>Units</th>
<th>Normal Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac Index (CI)</td>
<td>( \text{CO/BSA} )</td>
<td>L/min/m^2</td>
<td>2.5 to 4</td>
</tr>
<tr>
<td>Stroke Volume (SV)</td>
<td>( (\text{CO/HR}) \times 1000 )</td>
<td>ml/beat</td>
<td>60 to 130</td>
</tr>
<tr>
<td>Stroke Volume Index (SVI)</td>
<td>( \text{SV/BSA} )</td>
<td>ml/beat/m^2</td>
<td>30 to 65</td>
</tr>
<tr>
<td>Systemic Vascular Resistance (SVR)</td>
<td>( 79.9 \times \left[ \frac{\text{MAP} - \text{CVP}}{\text{CO}} \right] )</td>
<td>dynes \times \text{sec/cm}^5</td>
<td>900 to 1400</td>
</tr>
<tr>
<td>Systemic Vascular Resistance Index (SVRI)</td>
<td>( 79.9 \times \left[ \frac{\text{MAP} - \text{CVP}}{\text{CI}} \right] )</td>
<td>(dynes \times \text{sec/cm}^5) \times m^2</td>
<td>1760 to 2600</td>
</tr>
<tr>
<td>Pulmonary Vascular Resistance (PVR)</td>
<td>( 79.9 \times \left[ \frac{\text{MPA} - \text{PCWP}}{\text{CO}} \right] )</td>
<td>dynes \times \text{sec/cm}^5</td>
<td>20 to 130</td>
</tr>
<tr>
<td>Pulmonary Vascular Resistance Index (PVRI)</td>
<td>( 79.9 \times \left[ \frac{\text{MPA} - \text{PCWP}}{\text{CI}} \right] )</td>
<td>(dynes \times \text{sec/cm}^5) \times m^2</td>
<td>36 to 235</td>
</tr>
<tr>
<td>Left Ventricular Stroke Work (LVSW)</td>
<td>( 0.0136 \times \text{SV} \times (\text{MAP} - \text{PCWP}) )</td>
<td>g \times \text{min/beat}</td>
<td></td>
</tr>
<tr>
<td>Left Ventricular Stroke Work Index (LVSWI)</td>
<td>( \frac{\text{LVSW}}{\text{BSA}} )</td>
<td>g \times \text{min/beat/m}^2</td>
<td>45 to 75</td>
</tr>
<tr>
<td>Right Ventricular Stroke Work (RVSW)</td>
<td>( 0.0136 \times \text{SV} \times (\text{MPA} - \text{CVP}) )</td>
<td>g \times \text{min/beat}</td>
<td></td>
</tr>
<tr>
<td>Right Ventricular Stroke Work Index (RVSWI)</td>
<td>( \frac{\text{RVSW}}{\text{BSA}} )</td>
<td>g \times \text{min/beat/m}^2</td>
<td>4 to 8</td>
</tr>
</tbody>
</table>

Pressure values measured in kPa are automatically converted to mmHg prior to calculation.
Respiration Calculations

Respiration calculations describe the performance of the lungs in the ventilation process. Most input values for respiration calculations must be manually entered, unless you have a ventilator Flexport system interface.

To view respiration calculations:
- Access Local or Remote Calcs.
- Touch RESP CALCS.

<table>
<thead>
<tr>
<th>Variable (Label)</th>
<th>Equations</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minute Volume (VMIN)</td>
<td>VT × RR/1000</td>
<td>L/min</td>
</tr>
<tr>
<td>Static Compliance (Cst)</td>
<td>VT/(PLT – PEEP)</td>
<td>ml/cmH2O</td>
</tr>
<tr>
<td>Dynamic Compliance (Cdyn)</td>
<td>VT/(PIP – PEEP)</td>
<td>ml/cmH2O</td>
</tr>
<tr>
<td>Dead Space Volume (VD)</td>
<td>(PaCO2 – PECO2) × (VT/PaCO2)</td>
<td>ml</td>
</tr>
<tr>
<td>Dead Space to Tidal Volume Ratio (VD/VT)</td>
<td>VD/VT</td>
<td>(ratio)</td>
</tr>
<tr>
<td>Alveolar Ventilation (VA)</td>
<td>(VT − VD) × RR</td>
<td>ml/min</td>
</tr>
</tbody>
</table>

Table 5: Respiration Inputs

<table>
<thead>
<tr>
<th>Label</th>
<th>Name</th>
<th>Units</th>
<th>Default Value</th>
<th>Valid Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>RR</td>
<td>Respiration Rate</td>
<td>BPM</td>
<td>20</td>
<td>0 to 200</td>
</tr>
<tr>
<td>PaCO2</td>
<td>Partial Pressure of Arterial Carbon Dioxide</td>
<td>mmHg</td>
<td>40</td>
<td>0 to 150</td>
</tr>
<tr>
<td>PaCO2</td>
<td>Partial Pressure of Arterial Carbon Dioxide</td>
<td>kPa</td>
<td>5.3</td>
<td>0 to 20</td>
</tr>
<tr>
<td>VT</td>
<td>Tidal Volume</td>
<td>ml/breath</td>
<td>500</td>
<td>0 to 3000</td>
</tr>
<tr>
<td>PIP</td>
<td>Peak Inspiratory Pressure</td>
<td>cmH2O</td>
<td>50</td>
<td>0 to 200</td>
</tr>
<tr>
<td>PLT</td>
<td>Plateau Pressure</td>
<td>cmH2O</td>
<td>30</td>
<td>0 to 200</td>
</tr>
<tr>
<td>PEEP</td>
<td>Positive End Expiratory Pressure</td>
<td>cmH2O</td>
<td>10</td>
<td>0 to 50</td>
</tr>
<tr>
<td>PECO2</td>
<td>Partial Pressure of Expired Carbon Dioxide</td>
<td>mmHg</td>
<td>35</td>
<td>0 to 150</td>
</tr>
<tr>
<td></td>
<td>Partial Pressure of Expired Carbon Dioxide</td>
<td>kPa</td>
<td>4.7</td>
<td>0 to 20</td>
</tr>
</tbody>
</table>

Table 6: Respiration Outputs
Oxygenation Calculations

Oxygenation calculations provide specific data describing the efficiency with which the body acquires, circulates, and uses oxygen in the cardiopulmonary system. Input values for oxygenation calculations are automatically obtained from SpO₂, SvO₂, cardiac output modules, or Flexport interfaces. You must manually enter inputs for laboratory blood analysis values. Refer to Table 2 and Table 3 for BSA and CO values.

To view oxygenation calculations:
- Access Local or Remote Calcs.
- Touch OXY CALCS.

<table>
<thead>
<tr>
<th>Label</th>
<th>Name</th>
<th>Units</th>
<th>Default Value</th>
<th>Valid Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>FiO₂</td>
<td>Fractional Inspired Oxygen</td>
<td>%</td>
<td>50</td>
<td>0 to 100</td>
</tr>
<tr>
<td>PaO₂</td>
<td>Partial Pressure of Arterial Oxygen</td>
<td>mmHg kPa</td>
<td>100 13.3</td>
<td>0 to 500 0</td>
</tr>
<tr>
<td>SpO₂</td>
<td>Arterial Oxygen Saturation</td>
<td>%</td>
<td>97</td>
<td>0 to 100</td>
</tr>
<tr>
<td>PaCO₂</td>
<td>Partial Pressure of Arterial Carbon Dioxide</td>
<td>mmHg kPa</td>
<td>40 5.3</td>
<td>0 to 150 0</td>
</tr>
<tr>
<td>PvO₂</td>
<td>Partial Pressure of Mixed Venous Oxygen</td>
<td>mmHg kPa</td>
<td>38 5.1</td>
<td>0 to 99 0</td>
</tr>
<tr>
<td>SvO₂</td>
<td>Mixed Venous Oxygen Saturation</td>
<td>%</td>
<td>75</td>
<td>0 to 99</td>
</tr>
<tr>
<td>Hgb</td>
<td>Hemoglobin</td>
<td>g/dl</td>
<td>15</td>
<td>0 to 50.0</td>
</tr>
<tr>
<td>PB</td>
<td>Barometric Pressure</td>
<td>mmHg kPa</td>
<td>760 101.3</td>
<td>0 to 1000 0</td>
</tr>
</tbody>
</table>

Table 7: Oxygenation Inputs
Calculations

Calculating $O_2$AV, $O_2$AVI, VO$_2$, and VO$_2$I requires a CO value to complete the calculations. The most recent CO value (less than 15 minutes old) is used for these calculations, if it is available.

**Table 8: Oxygenation Outputs**

<table>
<thead>
<tr>
<th>Variable (Label)</th>
<th>Equations</th>
<th>Units</th>
<th>Normal Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen Availability ($O_2$AV)</td>
<td>$C_T a O_2 \times CO \times 10$</td>
<td>ml/min</td>
<td>900 to 1100</td>
</tr>
<tr>
<td>Oxygen Availability Index ($O_2$AVI)</td>
<td>$O_2$AV/BSA</td>
<td>ml/min/m$^2$</td>
<td>497 to 608</td>
</tr>
<tr>
<td>Arterial Oxygen Content ($C_T a O_2$)</td>
<td>$(1.34 \times Hgb \times SpO_2/100) + (PaO_2 \times 0.0031)$</td>
<td>ml/dl</td>
<td>18 to 20</td>
</tr>
<tr>
<td>Mixed Venous Oxygen Content ($C_T v O_2$)</td>
<td>$(1.34 \times Hgb \times SvO_2/100) + (PvO_2 \times 0.0031)$</td>
<td>ml/dl</td>
<td>14 to 16</td>
</tr>
<tr>
<td>Arterial/Venous Oxygen Difference (avDO$_2$)</td>
<td>$C_T a O_2 - C_T v O_2$</td>
<td>ml/dl</td>
<td>3 to 5.5</td>
</tr>
<tr>
<td>Oxygen Consumption (VO$_2$)</td>
<td>$avDO_2 \times CO \times 10$</td>
<td>ml/min</td>
<td>200 to 300</td>
</tr>
<tr>
<td>Oxygen Consumption Index (VO$_2$I)</td>
<td>$VO_2/BSA$</td>
<td>ml/min/m$^2$</td>
<td>110 to 166</td>
</tr>
<tr>
<td>Oxygen Extraction Ratio ($O_2$ER)</td>
<td>$VO_2/O_2$AV (Simplifies to avDO$_2$/C_TaO$_2$)</td>
<td>(ratio)</td>
<td>1/4 or 0.25</td>
</tr>
<tr>
<td>Partial Pressure of Alveolar Oxygen (PAO$_2$)</td>
<td>$[(FiO_2/100) \times (PB - 47)] - PaCO_2/0.8$</td>
<td>mmHg</td>
<td>100</td>
</tr>
<tr>
<td>Pulmonary Venous Admixture Shunt (Qs/Qt)</td>
<td>$100 \times [(1.34 \times Hgb) + (0.0031 \times PAO_2) - C_T a O_2] / (1.34 \times Hgb) + (0.0031 \times PAO_2 - C_T v O_2)$</td>
<td>%</td>
<td>Variable, depending on FiO$_2$</td>
</tr>
<tr>
<td>PaO$_2$/FiO$_2$ Ratio (P/F)</td>
<td>$PaO_2/(FiO_2/100)$</td>
<td>mmHg or kPa</td>
<td>Variable, depending on FiO$_2$</td>
</tr>
</tbody>
</table>
Renal Calculations

Renal calculations provide data related to kidney function. Input for renal calculations, other than a previously entered BSA, must be manually entered and may be derived from laboratory measurements. The system automatically computes BSA when you enter a height and weight into this menu. Refer to Table 2 for BSA values.

To view current renal calculations:
- Access Local or Remote Calcs.
- Touch RENAL CALCS.

### Table 9: Renal Inputs

<table>
<thead>
<tr>
<th>Label</th>
<th>Name</th>
<th>Units</th>
<th>Default Value</th>
<th>Valid Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>URK</td>
<td>Urine Potassium</td>
<td>mEq/L</td>
<td>60</td>
<td>0 to 300</td>
</tr>
<tr>
<td>PLOSM</td>
<td>Plasma Osmolality</td>
<td>mOsm/L</td>
<td>290</td>
<td>0 to 999</td>
</tr>
<tr>
<td>UROSM</td>
<td>Urine Osmolality</td>
<td>mOsm/L</td>
<td>575</td>
<td>0 to 9999</td>
</tr>
<tr>
<td>SerNa</td>
<td>Serum Sodium</td>
<td>mEq/L</td>
<td>140</td>
<td>0 to 999</td>
</tr>
<tr>
<td>CR</td>
<td>Serum Creatinine</td>
<td>mg/dl</td>
<td>1.10</td>
<td>0 to 9.99</td>
</tr>
<tr>
<td>UCR</td>
<td>Urine Creatinine</td>
<td>mg/dl</td>
<td>50.0</td>
<td>0 to 999.9</td>
</tr>
<tr>
<td>BUN</td>
<td>Blood Urea Nitrogen</td>
<td>mg/dl</td>
<td>12</td>
<td>0 to 999</td>
</tr>
<tr>
<td>URNA</td>
<td>Urine Sodium</td>
<td>mEq/L</td>
<td>90</td>
<td>0 to 999</td>
</tr>
<tr>
<td>URINE</td>
<td>Urine Volume</td>
<td>ml/day</td>
<td>2000</td>
<td>0 to 9999</td>
</tr>
</tbody>
</table>

### Table 10: Renal Outputs

<table>
<thead>
<tr>
<th>Variable (Label)</th>
<th>Equations</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine Sodium Excretion (URNaEX)</td>
<td>URNa × URINE/1000</td>
<td>mEq/day</td>
</tr>
<tr>
<td>Urine Potassium Excretion (URKEX)</td>
<td>URK × URINE/1000</td>
<td>mEq/day</td>
</tr>
<tr>
<td>Urine Sodium to Urine Potassium Ratio (Na/K)</td>
<td>URNa/URK</td>
<td>(ratio)</td>
</tr>
<tr>
<td>Osmolar Clearance (COSM)</td>
<td>(UROSM/PLOSM) × URINE</td>
<td>ml/day</td>
</tr>
<tr>
<td>Water Clearance (CH₂O)</td>
<td>URINE – COSM</td>
<td>ml/day</td>
</tr>
</tbody>
</table>
Calculations

Table 10: Renal Outputs  (continued)

<table>
<thead>
<tr>
<th>Variable (Label)</th>
<th>Equations</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine Osmolality to Plasma Osmolality Ratio (U/POSM)</td>
<td>UROSM/PLOSM</td>
<td>(ratio)</td>
</tr>
<tr>
<td>Fractional Sodium Excretion (FENa)</td>
<td>(URNa/SerNa) × (CR/UCR) × 100</td>
<td>%</td>
</tr>
<tr>
<td>Creatinine Clearance (CRCL)</td>
<td>(UCR/CR) × URINE/1440 × 1.73/BSA</td>
<td>ml/min/m²</td>
</tr>
<tr>
<td>Non-Saline Loss (NSLOSS)</td>
<td>URINE – (URINE × URNa/SerNa)</td>
<td>ml/day</td>
</tr>
<tr>
<td>BUN to Creatinine Ratio (BUN/CR)</td>
<td>BUN/CR</td>
<td>(ratio)</td>
</tr>
<tr>
<td>Urine Creatinine to Serum Creatinine Ratio (U/CR)</td>
<td>UCR/CR</td>
<td>(ratio)</td>
</tr>
</tbody>
</table>

Setting Up Drug Dosage Calculations

The Drug Dosage calculation feature enables you to edit the inputs and store up to six drug records.

From the Drug Dosage menu, you can:

- Edit the inputs (refer to Editing Inputs and Changing Units of Measurement on page 19-23)
- Store up to six drug records (refer to Storing a Record on page 19-24)
- Display two titration tables for each of these drug records (refer to Displaying Titration Tables on page 19-25)
- Print any of the displayed information (refer to Printing Calculations Data on page 19-26)

To access drug dosage calcs:

- Touch SPECIAL FUNCTIONS.
- Touch LOCAL TRENDS/CALCS or REMOTE TRENDS/CALCS.
- If you selected REMOTE TRENDS/CALCS, then select a bed.
- Touch DRUG CALCS.

To enter a drug dose value:

- Access Local or Remote Drug Calcs as described above.
- Select DRUG A, B, C, D, E, or F.
- Touch EDIT INPUTS.
- Select the desired input key.
- Use the on-screen keypad to change the value.
- Touch ENTER on the on-screen keypad.
Calculations

Drug dosage calculations operate similarly to physiologic calculations, except for the following differences:

- Weight is handled differently. When you begin drug dosage calculations, the patient's currently stored weight (automatically converted to kilograms) appears in the table. Weight must be entered in kilograms. While WEIGHT is the only drug dosage input automatically entered by the system, default values are present when you first display the table. You can edit any value by manually entering a new value.
- Patient type is controlled by the setting made in the Patient Demographics dialog box.

Display Detail — Drug Dosage Calculations

When you touch DRUG CALCS, either the Adult display or the Neonatal Drug Calcs display displays, along with the Drug Dosage menu keys (refer to Figure 19-4 through Figure 19-6). The Drug Dosage calculations table has a different format than the physiologic calculations table, but occupies the same four lower display zones.

Note: Because only three columns appear on the display at one time, each illustration includes two displays — one with columns for Drug A, B, and C, and one with columns for Drug D, E, and F.

Figure 19-3: Adult drug calculations (drug keys A through C)
Calculations

Figure 19-4: Adult drug calculations (drug keys D through F)

Figure 19-5: Neonatal drug calculations (drug keys A through C)
Identifies adult or neonatal drug calculations, the bed name, patient name, and date

Selected DRUG key

Drug Calculations data

MIX/TITRATE key (neonatal only)

Select the DRUG A through F keys as you selected the day/time keys in the physiologic calculations tables. Selecting a drug key enables you to edit the data in the column below it.

You can enter drug values for adults or neonates, depending on the current patient type selection (refer to Changing or Entering New Patient Data on page 7-3 for more information). If NEONATE was selected, the MIX/TITRATE key displays. The MIX/TITRATE key toggles to highlight either MIX or TITRATE, and affects how calculations are performed when the DOSE is edited. Each column’s default values are derived from common mixtures of frequently used drugs.
Editing Inputs and Changing Units of Measurement

To begin editing input values, touch the DRUG key. Touch EDIT INPUTS to display the Edit Inputs Menu.

Touching any input key on the Edit Inputs Menu, except DRUG, UNITS, or DOSE (described below), displays the on-screen keypad. During editing, the menu prompt shows the minimum and maximum values you can enter. Touch ENTER on the on-screen keypad to update the Drug Dosage table.

Table 11: Drug Dosage Calculations

<table>
<thead>
<tr>
<th>Label</th>
<th>Valid Range</th>
<th>Possible Units of Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMOUNT</td>
<td>0.01 to 9999.99</td>
<td>mcg, mg, g, mEq, units, k units, m units</td>
</tr>
<tr>
<td>VOLUME</td>
<td>1 to 9999</td>
<td>ml</td>
</tr>
<tr>
<td>CONC</td>
<td>0.01 to 9999.99</td>
<td>mcg/ml, mg/ml, g/ml, mEq/ml, units/ml, k units/ml, m units/ml</td>
</tr>
<tr>
<td>WEIGHT</td>
<td>0.2 to 250</td>
<td>kg</td>
</tr>
<tr>
<td>DOSE/MIN &amp; DOSE/HR</td>
<td>0.01 to 9999.99</td>
<td>* mcg/xx, mg/xx, g/xx, mEq/xx, units/xx, k units/xx, m units/xx</td>
</tr>
<tr>
<td>DOSE/WT/MIN &amp; DOSE/WT/HR</td>
<td>0.01 to 9999.99</td>
<td>* mcg/kg/xx, mg/kg/xx, g/kg/xx, mEq/kg/xx, units/kg/xx, k units/kg/xx, m units/kg/xx</td>
</tr>
<tr>
<td>RATE</td>
<td>0.1 to 999.99</td>
<td>ml/hr</td>
</tr>
<tr>
<td>DURATION</td>
<td>0.1 to 999.99</td>
<td>hr</td>
</tr>
<tr>
<td>TOTAL DOSE</td>
<td>0.01 to 9999.9</td>
<td>mcg, mg, g, mEq, units, k units, m units</td>
</tr>
<tr>
<td>TOTAL VOL</td>
<td>0.1 to 9999.99</td>
<td>ml</td>
</tr>
</tbody>
</table>

Units of measurement are displayed to the right of the data values in the table. The Select units menu enables you to choose one of three types of units (grams, mEq, and units) for AMOUNT or DOSE. Changing the unit type for AMOUNT changes the unit type for DOSE. Changing the selected units for AMOUNT may also change the displayed units for CONCENTRATION (CONC). Changing the selected units for DOSE may also change the displayed units for DOSE/WT and TOTAL DOSE.
Calculations

To change drug units:

- Access Local or Remote Drug Calcs.
- Select a Drug key.
- Touch EDIT INPUTS.
- Touch UNITS.
- Select the units to change.

Editing either AMOUNT or DOSE may scale the values and units for CONC, DOSE, DOSE/WT, and TOTAL DOSE up or down for values less than 0.01 or greater than 9999.99.

If the values for CONC, DOSE/HR, DOSE/WT/HR, and TOTAL DOSE exceed the range of their currently selected units, that value is divided by 1000 and the units change accordingly. For example, if the value for TOTAL DOSE is 123,456 mg, it will appear as 123.46 g. This value is rounded because only two digits can be displayed to the right of the decimal point.

Changing the units for DOSE may change the units for DOSE/WT and TOTAL DOSE. As a result, both the minute and hour values for DOSE and DOSE/WT may change.

When you select DOSE in the Edit Inputs menu, four dose type keys are displayed. Select any of these keys to edit the corresponding value shown in the Drug Dosage Calculations table. The system automatically calculates and displays the changes for the other three dose types in the Drug Dosage Calculations table.

The dose type selected for a specific drug defines the dose unit used for that drug's titration tables.

Storing a Record

Touch STORE ENTRY to store the record, and the letter s then appears under the associated DRUG key. You can store up to six records, one for each DRUG key. If you edit a record that has been stored, the system removes the letter s, because the newly edited changes have not yet been stored.

To store a drug record entry:

- Access Local or Remote Drug Calcs.
- Select a Drug key.
- Touch STORE ENTRY.
Calculations

Displaying Titration Tables

The VARY RATE/DOSE toggle key and DOSE TYPE keys are displayed when you touch TITRATION TABLE. VARY RATE varies the rate (holding the concentration constant) and calculates (titrates) the corresponding dose using the selected dose unit type. VARY DOSE varies the dose (holding the drug concentration constant) and titrates the corresponding delivery rate in ml/hr.

<table>
<thead>
<tr>
<th>To display titration tables:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Access Local or Remote Drug Calcs.</td>
</tr>
<tr>
<td>• Touch TITRATION TABLE.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To vary based on rate/dose:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Access Local or Remote Drug Calcs.</td>
</tr>
<tr>
<td>• Touch TITRATION TABLE.</td>
</tr>
<tr>
<td>• Touch VARY RATE/DOSE.</td>
</tr>
</tbody>
</table>

Touch the DOSE TYPE key while VARY / DOSE is selected to display the Dose Type menu. Selecting a key from this menu updates the Titration table to reflect the selected dose type.

In the titration tables, flow rate and dose are calculated using the equations below. Dosages can vary between 0.01 and 9999.99 mg/min, and rates can vary between 0.1 and 999.99 ml/hr.

\[
\text{RATE in ml/hr} = \frac{\text{DOSE} \times 60 \text{ minutes/1 hour}}{\text{AMOUNT/VOLUME}}
\]

\[
\text{DOSE in xx/min} = \frac{\text{FLOW RATE} \times \text{AMOUNT} \times 1\text{hour/60 minutes}}{\text{VOLUME}}
\]

Figure 19-8 shows a sample Vary Rate Titration table. The patient type (ADULT or NEONATAL) appears at the top of the table. The amount and volume appear below the patient type, along with the dose and rate units. The units for amount and dose are the same units used in the Drug Dosage table.

The drug (A through F) and patient weight appear in the upper right portion of the table.
Calculations

Use the SCROLL and PAGE keys in the **Titration Table** menu to select the range of data displayed in the titration table. The default range is 1 to 100.

**Note:**

*If any value in the Drug Calculation table is over its designated range, then ++++.++ appear for values of AMOUNT, CONC, DOSE, or RATE, and the TITRATION TABLE key becomes inaccessible.*

**Printing Calculations Data**

Touch the PRINT key to print the current page of the Calculations table. When using a two-channel printer, the top and bottom halves of the table print consecutively.

---

**To print calcs data:**

- Access Local or Remote Drug Calcs.
- Touch PRINT.
Recalculations

Table 12: Drug Dosage Equations

<table>
<thead>
<tr>
<th></th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONC</td>
<td>Amount/Volume</td>
</tr>
<tr>
<td>TOTAL VOL</td>
<td>Rate × Duration</td>
</tr>
<tr>
<td>TOTAL DOSE</td>
<td>Dose × Duration</td>
</tr>
</tbody>
</table>

You can recalculate all Drug Dosage inputs except for the amount/hour entries shown for DOSE and DOSE/WT. In most cases, changing one parameter automatically recalculates and redisplay other parameters under that DRUG key. Table 13 shows adult patient recalculation rules, except where noted in AMOUNT and VOLUME. When TITRATE on the MIX/TITRATE key is selected, DOSE, DOSE/WEIGHT, and FLOW RATE results are the same for adult and neonatal.

Table 13: Recalculation Rules

<table>
<thead>
<tr>
<th>Edit</th>
<th>Constants</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMOUNT (adult)</td>
<td>Holds VOLUME constant</td>
<td>Calculates CONC</td>
</tr>
<tr>
<td></td>
<td>Holds DOSE constant</td>
<td>Calculates RATE</td>
</tr>
<tr>
<td></td>
<td>Holds DUR constant</td>
<td>Calculates TOTAL VOL</td>
</tr>
<tr>
<td>AMOUNT (neonatal)</td>
<td>Holds VOLUME constant</td>
<td>Calculates CONC</td>
</tr>
<tr>
<td></td>
<td>Holds DUR constant</td>
<td>Calculates DOSE and TOTAL DOSE</td>
</tr>
<tr>
<td>VOLUME (adult)</td>
<td>Holds AMOUNT constant</td>
<td>Calculates CONC</td>
</tr>
<tr>
<td></td>
<td>Holds DOSE/MIN constant</td>
<td>Calculates RATE</td>
</tr>
<tr>
<td></td>
<td>Holds DUR constant</td>
<td>Calculates TOTAL VOL</td>
</tr>
<tr>
<td></td>
<td>Holds TOTAL DOSE constant</td>
<td></td>
</tr>
<tr>
<td>VOLUME (neonatal)</td>
<td>Holds AMOUNT constant</td>
<td>Calculates CONC</td>
</tr>
<tr>
<td></td>
<td>Holds RATE constant</td>
<td>Calculates DOSE</td>
</tr>
<tr>
<td></td>
<td>Holds DUR constant</td>
<td>Calculates TOTAL DOSE</td>
</tr>
<tr>
<td></td>
<td>Holds TOTAL VOL constant</td>
<td></td>
</tr>
<tr>
<td>CONC</td>
<td>Holds VOLUME constant</td>
<td>Calculates AMOUNT</td>
</tr>
<tr>
<td></td>
<td>Holds DOSE/MIN constant</td>
<td>Calculates RATE</td>
</tr>
<tr>
<td></td>
<td>Holds DUR constant</td>
<td>Calculates TOTAL VOL</td>
</tr>
</tbody>
</table>
### Calculations

#### Table 13: Recalculation Rules (continued)

<table>
<thead>
<tr>
<th>Edit</th>
<th>Constants</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>WEIGHT</td>
<td>Holds DOSE/MIN constant</td>
<td>Calculates DOSE/WEIGHT/MIN</td>
</tr>
<tr>
<td></td>
<td>Holds DOSE/HR constant</td>
<td>Calculates DOSE/WEIGHT/HR</td>
</tr>
<tr>
<td>DOSE or</td>
<td>Holds WEIGHT constant</td>
<td>Calculates other three DOSE and DOSE/WEIGHTS</td>
</tr>
<tr>
<td>DOSE/WEIGHT</td>
<td>Holds CONC constant</td>
<td>Calculates RATE</td>
</tr>
<tr>
<td>(TITRATE)</td>
<td>Holds DUR constant</td>
<td>Calculates TOTAL DOSE and TOTAL VOL</td>
</tr>
<tr>
<td>DOSE or</td>
<td>Holds WEIGHT constant</td>
<td>Calculates other three DOSE and DOSE/WEIGHTS</td>
</tr>
<tr>
<td>DOSE/WEIGHT</td>
<td>Holds RATE constant</td>
<td>Calculates CONC</td>
</tr>
<tr>
<td>(MIX)</td>
<td>Holds VOLUME constant</td>
<td>Calculates AMOUNT</td>
</tr>
<tr>
<td></td>
<td>Holds DUR constant</td>
<td>Calculates TOTAL DOSE</td>
</tr>
<tr>
<td>RATE (TITRATE)</td>
<td>Holds CONC constant</td>
<td>Calculates DOSE/WEIGHT/MIN and DOSE/WEIGHT/HR</td>
</tr>
<tr>
<td></td>
<td>Holds WEIGHT constant</td>
<td>Calculates DOSE/WEIGHT/MIN and DOSE/WEIGHT/HR</td>
</tr>
<tr>
<td></td>
<td>Holds DUR constant</td>
<td>Calculates TOTAL VOL and TOTAL DOSE</td>
</tr>
<tr>
<td>RATE (MIX)</td>
<td>Holds DOSE/HR constant</td>
<td>Calculates CONC</td>
</tr>
<tr>
<td></td>
<td>Holds VOLUME constant</td>
<td>Calculates AMOUNT</td>
</tr>
<tr>
<td></td>
<td>Holds DUR constant</td>
<td>Calculates TOTAL VOL</td>
</tr>
<tr>
<td>DUR</td>
<td>Holds DOSE/MIN constant</td>
<td>Calculates TOTAL DOSE</td>
</tr>
<tr>
<td></td>
<td>Holds RATE constant</td>
<td>Calculates TOTAL VOL</td>
</tr>
<tr>
<td>TOTAL DOSE</td>
<td>Holds CONC constant</td>
<td>Calculates RATE</td>
</tr>
<tr>
<td></td>
<td>Holds DUR constant</td>
<td>Calculates DOSE/MIN, DOSE/HR, and TOTAL VOL</td>
</tr>
<tr>
<td></td>
<td>Holds WEIGHT constant</td>
<td>Calculates DOSE/WEIGHT/MIN and DOSE/WEIGHT/HR</td>
</tr>
<tr>
<td>TOTAL VOL</td>
<td>Holds DUR constant</td>
<td>Calculates RATE</td>
</tr>
<tr>
<td></td>
<td>Holds CONC constant</td>
<td>Calculates DOSE/WEIGHT/MIN and DOSE/WEIGHT/HR</td>
</tr>
<tr>
<td></td>
<td>Holds WEIGHT constant</td>
<td>Calculates TOTAL DOSE</td>
</tr>
</tbody>
</table>
Configurable Drug Names

Using the Drug Name List

To use the list of drug names:

1. Touch the DRUG key in the Drug Calcs Edit Inputs menu to display the Drug Name List.

   ![Drug Name List](image)
   
   *Figure 19-9: Drug Name List*

2. Select a drug name from the list and touch ACCEPT to transfer the drug name along with its stored default values to the currently selected drug key (A through F). (Touching CANCEL closes the Drug Name List.) Drug Calcs will display the selected drug name below the key (refer to Figure 19-10).

   ![Drug Calcs display](image)
   
   *Figure 19-10: Drug Calcs display*

Note:

The drug default values for drugs A through F can be overwritten and not affect the master drug list entry. However, selecting another drug name for drug A, B, C, D, E, or F overrides all previously edited values and inserts the master default settings. Ensure that the changes are implemented after selecting the drug name (and not before).
Trends

Directory of Keys

Remote and Tabular Trends

Refer to Introduction
Refer to Alarms
Refer to Printing
Refer to Introduction

SPECIAL FUNCTIONS

LOCAL TRENDS/CALCS
REMOTE TRENDS/CALCS

TRENDS/CALCS for BED xxx

GRAPHIC TRENDS
TABULAR TRENDS

Refer to page 20-2

TABULAR TRENDS

CHANGE TIME INTERVAL

<table>
<thead>
<tr>
<th>TIME INTERVAL</th>
<th>PAGE</th>
<th>↑</th>
<th>↓</th>
<th>←</th>
<th>→</th>
<th>PRINT</th>
<th>GRAPHIC TRENDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 MIN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 MIN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 MIN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 MIN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 MIN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 HR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5 HR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 HR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ultraview SL2200 Operations Manual 20-1
Graphic Trends

TRENDS/CALCS for BED xxx

<table>
<thead>
<tr>
<th>GRAPHIC TRENDS</th>
<th>TABULAR TRENDS</th>
</tr>
</thead>
</table>

refer to page 20-1

GRAPHIC TRENDS

<table>
<thead>
<tr>
<th>TIME BASE</th>
<th>SIZE</th>
<th>TOP GRAPH</th>
<th>BOTTOM GRAPH</th>
<th>CURSOR ←</th>
<th>CURSOR →</th>
<th>EXPAND</th>
<th>PRINT</th>
<th>TABULAR TRENDS</th>
</tr>
</thead>
</table>

TREND PARAMETERS

<table>
<thead>
<tr>
<th>ECG HR</th>
<th>RESP RR</th>
<th>ART</th>
<th>TEMP</th>
</tr>
</thead>
</table>

Note: The number of keys and their labels will vary according to parameters currently being trended.

CHANGE SIZE

<table>
<thead>
<tr>
<th>RESP RR</th>
<th>ECG HR</th>
<th>ECG ABN</th>
</tr>
</thead>
</table>

Note: The number of keys and their labels will vary according to parameters currently being trended.

CHANGE TIME BASE

| 2 HRS | 6 HRS | 12 HRS | 24 HRS |

Note: The number of keys and their labels will vary according to parameters currently being trended.
Trends display numeric data collected for a patient over a 24-hour period in either a graphical or tabular format (similar to a common flowsheet or spreadsheet). Up to the last 24 hours of collected data are available, for as long as memory limitations allow. Data older than 24 hours do not display.

The monitor collects trend values every minute and collects episodic trend values as they become available, for all parameters except delta temperature and EEG. The monitor maintains settings for trend displays (time base, parameters, size, etc.) until you change them or until you view a new patient's trend.

To view a trend:

- Touch SPECIAL FUNCTIONS.
- Select LOCAL TRENDS/CALCS.
- If you selected REMOTE TRENDS/CALCS, select a bed.
- Select GRAPHIC TRENDS or TABULAR TRENDS.

(Follow these steps to start each Quickstart in this chapter.)

Note:

- When you suspend alarms with the ALARM SUSPEND key, the monitor may not collect trend data. Contact your system administrator to enable this function.
- Trends does not display data resulting from calculations.
- The message No trends available for this bed or Trend data not available appears if data have not yet been accumulated for the selected bed.
- Trend data are not collected while ECG or SpO₂ processing is suspended.
Display Detail

Graphic Trends

Graphic trends can appear in three formats:

- Continuous trends — Represent parameters with continuous monitoring. A solid line connects trend points.
- Episodic trends — Represent parameters that produce individual events. Episodic values appear as an x, +, or 0. A dotted line connects each episode. In most cases, an episodic trend contains at least 30 values.
- Histogram trends — Display as vertical bars starting at a base of zero.

![Figure 20-1: Graphic trend display](image)

1. Trend unit of measurement (unit labels do not display for parameters with one acknowledged unit of measurement, for example, ECG, RESP, and CO)
2. Scale value — use the SIZE key to select
3. Bed/patient ID
4. Cursor
5. Data values for top graph at the selected time
6. Upper trend graph time axis
7. Data values for bottom graph

Date: 18 Aug 2009

Values at
Time: 08:27

Left axis:
ART (mmHg)
SYS = 136
MEAN = (96)
DIA = 74

Left axis:
ECG
HR = 128
Right axis:
ABN = 10
Trends

8 Right axis for bottom graph
9 Lower trend graph time axis at the selected time
10 Left axis for bottom graph

The graphic trend cursor is a solid, vertical line that moves across the entire trend graph (refer to 4 in Figure 20-1). The home position of the cursor is at the extreme right end of the graph. When the cursor is at its home position, data values reflect current values and the Current Values label is displayed. Once the cursor moves from its home position, the values change to reflect data acquired from the patient at that cursor location time, and the Values at label and time are displayed.

Note:
- The trend graph continues to update, EXCEPT when the cursor is moved from its home position. It updates again when the cursor returns to its home position.
- When switching between graphic trends and tabular trends, the cursor maintains the same relative position.

To move the cursor, touch the cursor keys as needed.

Tabular Trends

You can view a tabular trend of continuous patient data and episodic patient data by touching the TABULAR TRENDS key. Data older than 24 hours do not display. Parameters always appear in descending order of priority. Data acquired on a continuous basis always precede episodic data. Episodic values are presented according to the sequence in which they were originally stored.

The tabular trend table displays up to 22 rows and 7 columns of parameter data on a single display. You can view additional parameters by scrolling or paging up or down. You can view data collected at other times by scrolling or paging left or right.

<table>
<thead>
<tr>
<th>1 Bed: 220</th>
<th>2 Patient: SMITH, JOHN</th>
<th>3 Date: 18 Aug 2009</th>
<th>4 CURRENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time (05:30)</td>
<td>06:00</td>
<td>06:30</td>
<td>07:00</td>
</tr>
<tr>
<td>HR (ECG) b/min</td>
<td>70</td>
<td>75</td>
<td>82</td>
</tr>
<tr>
<td>ABN b/min</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>RR (RESP) br/min</td>
<td>8</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>ART/s mmHg</td>
<td>165</td>
<td>137</td>
<td>165</td>
</tr>
<tr>
<td>MAP mmHg</td>
<td>136</td>
<td>136</td>
<td>136</td>
</tr>
<tr>
<td>ART/d mmHg</td>
<td>108</td>
<td>80</td>
<td>108</td>
</tr>
</tbody>
</table>

Figure 20-2: Tabular trend display

1 Bed identification
2 Patient name
When you select PAGE, the up and down arrow keys move the entire page up or down. When you select SCROLL, the up and down arrow keys move the display up or down one parameter row at a time.

When you select PAGE, the left and right arrow keys move the display to show an entirely new set of columns. When you select SCROLL, the left and right arrow keys move the display left or right by one column.

### To view additional tabular trend parameter data:
- Select PAGE or SCROLL.
- Use the ↑ and ↓ arrow keys to move parameter rows up or down.

### To view additional data collection times:
- Select PAGE or SCROLL.
- Use the ← and → arrow keys to move data columns left or right.

## Printing the Trend Display

You can print a copy of the displayed graphic or tabular trend at any time. When using a two-channel printer, the top and bottom halves of the trend display print consecutively.

### To print the trend display:
- Adjust the trend display as desired.
- Touch PRINT.
Trends

Graphic and Tabular Trend Settings

Selecting Trend Parameters

The first time you view a patient's graphic trend, the highest priority parameter appears on the bottom trend graph and the next highest priority parameter appears on the top graph. You can view other trends by selecting them from the Trend Parameter menu.

<table>
<thead>
<tr>
<th>To select a parameter for the top or bottom graph:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Select TOP GRAPH or BOTTOM GRAPH.</td>
</tr>
<tr>
<td>• Select the desired parameter.</td>
</tr>
</tbody>
</table>

Selecting a Scale Size

Initially, the system selects a scale that includes all monitored values for the displayed parameter. You can adjust the scale for each parameter using the arrow keys.

<table>
<thead>
<tr>
<th>To adjust the scale size:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch SIZE.</td>
</tr>
<tr>
<td>• Select desired parameter key.</td>
</tr>
<tr>
<td>• Use the arrow keys to adjust.</td>
</tr>
</tbody>
</table>

Selecting a Time Base and Expanding the Trend Display

The time base for each trend graph can be set for 2, 6, 12, or 24 hours. The displayed resolution for each time base is:

1. 2 hours = 1 minute
2. 6 hours = 1 minute
3. 12 hours = 2 minutes
4. 24 hours = 4 minutes

You can expand the trend display to include only an hour's worth of information. With EXPAND set to ON, the TIME BASE key is disabled and the trend graph stops updating. When EXPAND is OFF, the trend graph returns to its original display.
Setting a Tabular Trends Time Interval

You can display acquired data at the following time intervals: 1, 5, 10, 15, and 30 minutes; and 1, 1.5, and 3 hours. The trend table automatically updates at the end of each time interval, and all data columns shift to the left to include the new interval.

Note:

*Updating is suspended when you review data either by paging or scrolling.*

For continuous data, the value displayed in the tabular trend table is the value taken at the displayed time. It is not an average of all readings taken during that time period.

When more than one episodic reading occurs in the same time interval, only the most recent value displays. An asterisk to the right of an episodic value indicates that additional data entries are available for that time interval.

To set a time interval:
- Touch TIME INTERVAL.
- Select the desired time interval.
**Trends Troubleshooting Guide**

**Caution:**

Status messages indicate a problem or condition that may affect accurate monitoring values. Do not ignore these messages. Correct any fault before continuing.

<table>
<thead>
<tr>
<th>Clinical Situation</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current patient data not being added to trends</td>
<td>If alarms are suspended, data may not be trended at the bedside monitor.</td>
<td>Turn alarms ON or have your system administrator enable your system to trend while alarms are suspended.</td>
</tr>
<tr>
<td></td>
<td>ECG or SpO₂ processing is suspended.</td>
<td>Resume ECG or SpO₂ processing.</td>
</tr>
<tr>
<td></td>
<td>EXPAND key is ON (trend data will not be lost).</td>
<td>Set EXPAND key to OFF. Resume ECG or SpO₂ processing.</td>
</tr>
<tr>
<td></td>
<td>Cursor not in home position (trend data will not be lost).</td>
<td>Move the cursor to the extreme right position.</td>
</tr>
<tr>
<td>PCWP trend not available</td>
<td>PCWP values not saved.</td>
<td>Save the PCWP values.</td>
</tr>
<tr>
<td>Incorrect unit of measure displayed</td>
<td>Incorrect unit of measurement configured for system.</td>
<td>Contact your system administrator.</td>
</tr>
<tr>
<td>CALCS data not trending</td>
<td>Trends does not display Calcs data.</td>
<td>Use the <strong>Calcs</strong> menu to view this data.</td>
</tr>
<tr>
<td>NO TRENDS AVAILABLE FOR THIS BED message appears</td>
<td>No trend data has yet accumulated for the selected parameter.</td>
<td>Allow sufficient time for data to accumulate.</td>
</tr>
<tr>
<td>Numerous entries with ?? instead of vital signs</td>
<td>ALARM SUSPEND key was selected frequently.</td>
<td>Contact your system administrator to collect data during Alarm Suspend periods.</td>
</tr>
<tr>
<td></td>
<td>ECG/Resp or SpO₂ processing is suspended.</td>
<td>Resume ECG or SpO₂ processing.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ensure that ECG/Resp amplitude and signal quality are sufficient.</td>
</tr>
</tbody>
</table>
Patient Data Logger

Directory of Keys

SPECIAL FUNCTIONS

DATA LOGGER

PATIENT DATA LOGGER

ON OFF

SETUP

ALARM LOGGING CHECKSUMS SAMPLE RATE

ON OFF ON OFF 15 sec

Refer to Introduction
Refer to Alarms
Refer to Printing
Refer to Introduction
Patient Data Logger

Contents

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Overview

The Patient Data Logger option automatically sends patient vital signs from the monitor to an external device, such as a printer or a terminal. Episodic patient data is also sampled and transmitted. The output is in the form of ASCII text byte strings, and is printed using standard RS-232 serial communications via the monitor’s serial port (refer to Display Detail on page 21-4).

This option continues to send data whether the external device is online or offline. Data transmission can be stopped by reassigning the data port or disabling the Patient Data Logger.

Your system administrator (or other designated personnel) must first set up communication between the monitor and the external device by assigning the serial port to Patient Data Logger and then adjusting the serial port settings. The various serial settings can be adjusted to suit the device attached to the serial port. Refer to the appropriate service manual for more details.

To enable Patient Data Logger:
- Touch SPECIAL FUNCTIONS.
- Touch DATA LOGGER.
- Select PATIENT DATA LOGGER / ON.

To set the sample rate:
- Touch SPECIAL FUNCTIONS.
- Touch DATA LOGGER.
- Touch SETUP.
- Touch SAMPLE RATE until the desired rate appears.

The sample rate refers to the frequency of data sampling and can be set to time intervals ranging from 5 seconds to 60 minutes. The new sample rate takes effect immediately.
Display Detail

The Patient Data Logger information is automatically sent to an external device, such as a printer or terminal, once the serial port is assigned and toggled ON.

The data fields that appear on this report (ECG, RESP, ART, SpO2, and EtCO2) will vary depending on the parameter modules installed on the system.

<table>
<thead>
<tr>
<th>TIME</th>
<th>ECG HR</th>
<th>ABN</th>
<th>LEAD</th>
<th>LEAD2</th>
<th>ST1</th>
<th>ST2</th>
<th>RATE</th>
<th>SYS/DIA</th>
<th>MEAN</th>
<th>% RESP</th>
<th>%</th>
<th>AGENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>14:55:49</td>
<td>212</td>
<td>0</td>
<td>VI</td>
<td>II</td>
<td>2.08</td>
<td>-2.00</td>
<td>52</td>
<td>138/81</td>
<td>109</td>
<td>93</td>
<td>0</td>
<td>0.1</td>
</tr>
<tr>
<td>14:55:54</td>
<td>158</td>
<td>0</td>
<td>VI</td>
<td>II</td>
<td>2.08</td>
<td>-2.00</td>
<td>47</td>
<td>138/81</td>
<td>109</td>
<td>95</td>
<td>0</td>
<td>0.1</td>
</tr>
<tr>
<td>14:55:59</td>
<td>146</td>
<td>0</td>
<td>VI</td>
<td>II</td>
<td>2.08</td>
<td>-2.00</td>
<td>39</td>
<td>138/81</td>
<td>110</td>
<td>96</td>
<td>0</td>
<td>0.1</td>
</tr>
<tr>
<td>14:56:04</td>
<td>146</td>
<td>0</td>
<td>VI</td>
<td>II</td>
<td>2.08</td>
<td>-2.00</td>
<td>36</td>
<td>138/81</td>
<td>110</td>
<td>97</td>
<td>0</td>
<td>0.1</td>
</tr>
<tr>
<td>14:56:10</td>
<td>212</td>
<td>0</td>
<td>VI</td>
<td>II</td>
<td>2.08</td>
<td>-2.00</td>
<td>47</td>
<td>138/81</td>
<td>109</td>
<td>97</td>
<td>0</td>
<td>0.1</td>
</tr>
<tr>
<td>14:56:15</td>
<td>200</td>
<td>0</td>
<td>VI</td>
<td>II</td>
<td>2.08</td>
<td>-2.00</td>
<td>53</td>
<td>138/81</td>
<td>110</td>
<td>97</td>
<td>16</td>
<td>5.2</td>
</tr>
<tr>
<td>14:56:20</td>
<td>146</td>
<td>0</td>
<td>VI</td>
<td>II</td>
<td>2.08</td>
<td>-2.00</td>
<td>43</td>
<td>138/81</td>
<td>110</td>
<td>97</td>
<td>16</td>
<td>5.2</td>
</tr>
<tr>
<td>14:56:25</td>
<td>146</td>
<td>0</td>
<td>VI</td>
<td>II</td>
<td>1.84</td>
<td>-2.56</td>
<td>36</td>
<td>138/81</td>
<td>109</td>
<td>97</td>
<td>16</td>
<td>5.2</td>
</tr>
<tr>
<td>14:56:30</td>
<td>211</td>
<td>0</td>
<td>VI</td>
<td>II</td>
<td>1.84</td>
<td>-2.56</td>
<td>43</td>
<td>138/81</td>
<td>110</td>
<td>97</td>
<td>16</td>
<td>5.2</td>
</tr>
<tr>
<td>14:56:35</td>
<td>212</td>
<td>0</td>
<td>VI</td>
<td>II</td>
<td>1.84</td>
<td>-2.56</td>
<td>53</td>
<td>138/81</td>
<td>110</td>
<td>97</td>
<td>16</td>
<td>5.2</td>
</tr>
<tr>
<td>14:56:45</td>
<td>146</td>
<td>0</td>
<td>VI</td>
<td>II</td>
<td>1.84</td>
<td>-2.56</td>
<td>36</td>
<td>138/81</td>
<td>110</td>
<td>97</td>
<td>16</td>
<td>5.2</td>
</tr>
<tr>
<td>14:56:52</td>
<td>200</td>
<td>0</td>
<td>VI</td>
<td>II</td>
<td>1.84</td>
<td>-2.56</td>
<td>39</td>
<td>138/81</td>
<td>109</td>
<td>79</td>
<td>16</td>
<td>5.2</td>
</tr>
</tbody>
</table>

Figure 21-1: Sample Patient Data Logger report

The PDL transmits two types of information: page headers and data lines. The page header appears at the top of each page and contains the patient's name, the bed number, and the current date.

A new page is generated when any of the following situations occur:

- The end of a page is reached (50 data lines have been transmitted).
- The monitored vital signs parameters change.
- The patient name or bed number changes.
- The current date changes.

Data lines are transmitted at the interval specified at configuration. Each data line contains the time that the data was collected, as well as the data collected for each vital sign parameter being monitored.
Patient Data Logger

Each line of the data printout may contain up to 132 characters and is terminated with line-feed and carriage-return characters.

Note:

- If you are monitoring a large number of parameters and have an 80-column printer, the data from one reading may require more than one line. If your printer has a wrap-around feature, this will be handled automatically. If you prefer that each data reading fits onto one line, condense the printer’s type or use a wide-carriage (132 column) printer.

- The report prints data from a maximum of 11 parameter groups (for example, ECG, RESP, ART). (Fewer parameters are printed if the line length limit is reached.)
<table>
<thead>
<tr>
<th>Clinical Situation</th>
<th>Possible Causes</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data is displayed with improper spacing or double spacing</td>
<td>■ The PDL interface sends a carriage return/line feed sequence at each end-of-line. The external device may not be set up properly.</td>
<td>■ Set the external device for “0” line feed.</td>
</tr>
<tr>
<td>No data is displayed or printed on the external device</td>
<td>■ There is a power problem or the cables are faulty. The device may not be set up properly.</td>
<td>■ Check the power and cables. Ensure that the device is in the ONLINE mode and that RS-232 port requirements are satisfied. ■ Check for RS-232 compatibility at the monitor and at the external device. ■ Check the monitor port assignments and port connections.</td>
</tr>
<tr>
<td>Data is lost or garbled</td>
<td>■ The cable is faulty.</td>
<td>■ Check the cables.</td>
</tr>
<tr>
<td></td>
<td>■ The parity is set incorrectly.</td>
<td>■ Verify the baud rates and parity settings.</td>
</tr>
<tr>
<td></td>
<td>■ Baud rate settings may be inappropriate.</td>
<td></td>
</tr>
</tbody>
</table>
Remote Keypad

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Selecting and Printing a Parameter .......................... 4
Operating Menu Keys ........................................... 5
Remote Keypad Troubleshooting Guide ....................... 6

Overview

The remote keypad is a cordless, hand-held transmitter powered by an internal battery (refer to Figure 22-1). It sends your instructions, via infrared signals, to the monitor’s receiver, providing all the functions you need to operate your monitor remotely.

The wireless remote control keypad (90360-01) enables you to remotely suspend or adjust alarms, access graphic trends, adjust waveform size, print, etc. The zoom function enlarges menu keys on the monitor, making them easy to read from across the room.

Note:

- The maximum operating range is 20 feet at an angle of up to 45 degrees on either side of the receiver.
- The remote keypad cursor remains on the monitor display for approximately one minute following the last keypad activity, or until you touch the touchscreen itself.
Remote Keypad

Figure 22-1: Remote keypad

- Press to move cursor up, down, right or left within an application.
- Press to enlarge keys for ease of viewing at a distance.
- Press to change focus among multiple applications or to place cursor on first menu key (or icon).
- Press as necessary to enter a numeric value or to position cursor.
- Press to delete a previous entry.
- Press to activate the key highlighted with the cursor or to enter the security code in access mode.
- Press to place cursor on first parameter key.
- Press to set or verify access code.

Ultraview SL2200 Operations Manual
Remote Keypad

Setting Up the Receiver

The infrared receiver is built into the SL2200 monitor.

Access Codes

Access codes prevent interference from other remote keypads when monitors are located near each other, by ensuring that the receiver responds only to a remote keypad with a matching code number. If a keypad's access code differs from the receiver's, the command is ignored. The programmed access code (1 to 32) is displayed on the receiver. This code is stored in the monitor's memory and retained whenever the monitor is reset or powered OFF.

Remote keypad systems can also be operated in an UNSECURED mode without access codes, so that the receiver accepts commands from any remote keypad. When in the UNSECURED mode, the word ALL appears on the monitor.

When programming a monitor's access code, the keypad's access code must initially match the receiver's. The new access code is programmed simultaneously with the keypad's. The receiver temporarily displays the remote keypad's access code, then returns to displaying its own code.

Note:

*To prevent inadvertently changing other access codes, unplug all other monitors (or move the remote keypad directly in front of the monitor to be programmed) and place your finger over the remote keypad's infrared window during programming (sufficient signal transmits through your finger to program the receiver).*

---

<table>
<thead>
<tr>
<th>To select the UNSECURED mode from the monitor display:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Touch MONITOR SETUP.</td>
</tr>
<tr>
<td>• Touch PRIVILEGED ACCESS.</td>
</tr>
<tr>
<td>• Enter the Clinical password.</td>
</tr>
<tr>
<td>• Touch REMOTE KEYPAD STATION ADDRESS.</td>
</tr>
<tr>
<td>• Select SECURE MODE / OFF.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To verify a remote keypad's current access code:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Point the remote keypad at the monitor's receiver.</td>
</tr>
<tr>
<td>• Touch ACCESS CODE.</td>
</tr>
<tr>
<td>• Touch ENTER.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To set a remote keypad's access code:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Point the remote keypad at the monitor's receiver.</td>
</tr>
<tr>
<td>• Touch ACCESS CODE.</td>
</tr>
<tr>
<td>• Select the first digit.</td>
</tr>
<tr>
<td>• Select the second digit.</td>
</tr>
<tr>
<td>• Touch ENTER.</td>
</tr>
</tbody>
</table>
Selecting and Printing a Parameter

The parameter keys display vertically near the right side of the display, with parameter number one at the top. On a split-view central display, parameter number one is at the top of the left column. Press the WAVEFORM key to activate the PARAMETER SELECTION mode.

After you activate the RECORD key, you have two seconds to highlight a parameter key. To ensure enough time in making a selection, place the cursor on the desired parameter key before you press the RECORD key on the remote keypad.

**Note:**

*When printing several parameters at the same time, or when trying to print an event such as a single abnormal beat, it is easier to use the keys on the monitor rather than on the remote keypad to direct the recording.*

**To set the monitor's access code:**

- Touch MONITOR SETUP.
- Touch PRIVILEGED ACCESS.
- Enter the Clinical password.
- Touch REMOTE KEYPAD STATION ADDRESS.
- Select SECURE MODE / ON.

**To select a parameter:**

- Point the remote keypad at the monitor’s receiver.
- Press WAVEFORM for parameter number 1.
- Press the up or down arrow keys to position the cursor on the desired parameter.
- Press ENTER.

**To print data from a waveform zone:**

- Point the remote keypad at the monitor’s receiver.
- Press the up or down arrow keys to position the cursor on the desired parameter.
- Press RECORD.
- Select another parameter, as necessary.
- Press ENTER.
Operating Menu Keys

The menu keys display horizontally across the bottom of the monitor, with menu key number one at the far left. Press the ZOOM key once to activate the zoom feature, making each key easier to see. Press the ZOOM key again to turn OFF the zoom feature.

To operate menu keys:
- Point remote keypad at the monitor’s receiver.
- Select a parameter key.
- Press MENU.
- Press the left or right arrow key to the desired position.
## Remote Keypad Troubleshooting Guide

<table>
<thead>
<tr>
<th>Clinical Situation</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitor accepts commands from any keypad</td>
<td>Monitor operating in an UNSECURED mode.</td>
<td>Select an access code, and program both the monitor/receiver and the keypad to that code.</td>
</tr>
<tr>
<td>During programming, another receiver was inadvertently changed</td>
<td>Remote keypad placed too close to another monitor’s receiver.</td>
<td>Move the keypad directly in front of the receiver to be programmed and place your finger over the keypad infrared window during programming.</td>
</tr>
<tr>
<td>Monitor does not respond</td>
<td>Monitor may not support remote keypad.</td>
<td>Press the ACCESS CODE key. If an \textit{A} does not appear below the NORMAL SCREEN key on the monitor, contact your system administrator or biomedical engineer.</td>
</tr>
<tr>
<td></td>
<td>Depleted battery in remote keypad.</td>
<td>Replace battery in remote keypad.</td>
</tr>
</tbody>
</table>
Product Specifications

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System Safety Specifications ............................... 1
Equipment Classification .................................. 3
Equipment Maintenance Requirements ............... 4
Module Compatibility ....................................... 5
Warnings and Cautions ..................................... 5

Intended Use

The devices documented herein are intended to be used for monitoring of multiple physiological parameters for patients of any age ranging from neonates through adults. In addition to monitoring physiological parameters, these devices also support recording and alarming for those parameters.

The devices documented herein are not therapeutic devices. The devices documented herein are to be used by trained health care professionals in health care facilities. ST segment monitoring is restricted to adult patients only. The devices documented herein are not intended for home use.

Rx Only
US Federal law restricts the devices documented herein to sale by, or on the order of, a physician.

Indication for Use

The devices documented herein are indicated for use by health care professionals whenever there is a need for monitoring of the physiological parameters of patients.

System Safety Specifications

The monitor’s input circuits are designed for use with electrosurgical equipment and defibrillators. Sensors may remain attached to the patient during defibrillation or while an electrosurgical unit is in use, however the readings may be inaccurate during and shortly after use of such equipment. Cardiac pacemakers or other electrical stimulators should not affect or be affected by the operation of this unit.

The Introduction on page 1-1 includes information concerning the interconnection of equipment within the Ultraview SL Network. Initial connection of auxiliary, line-operated equipment to a monitor must be performed by a hospital biomedical engineer or a Spacelabs Healthcare Field Service Engineer. For additional information, or instructions regarding interconnection of units, contact a qualified field service engineer or your local Spacelabs Healthcare representative.

After installation and/or interconnection with other units, the equipment leakage current shall not exceed the local (provincial) acceptable values.
Accessory equipment connected to the analog and digital interfaces must be certified according to the respective IEC standards (i.e., IEC 60950 for data processing equipment and IEC 60601-1 for medical equipment). All configurations shall comply with the system standard IEC 60601-1-1+A1. Everyone who connects additional equipment to the signal input part or signal output part is configuring a medical system and is, therefore, responsible for ensuring that the system complies with the requirements of the system standard IEC 60601-1-1+A1 and the electromagnetic compatibility system standard IEC 60601-1-2. If in doubt, consult with a qualified field service engineer.

All Spacelabs Healthcare equipment is intended for use with a fixed mains socket-outlet. If a system is configured using multiple portable socket-outlets, this system must be reviewed for compliance with IEC 60601-1-1+A1, including the maximum load and enclosure leakage currents requirements. The multiple portable socket outlet cannot be placed on the floor. If the leakage current limit is exceeded, a second Protective Earth, fixed at both ends with a tool, may be necessary. This second Protective Earth must be tested to the requirements of clause 18 of IEC 60601-1.

Equipment weighing more than 20 kg is not portable. To lift heavy equipment, support under corners and lift according to hospital procedures.

**Warning:**

*Do not lift the monitor by connected cables or power cords because they might disconnect from the monitor, causing the monitor to drop on the patient.*

Use of patient cables, transducers, sensors, and supplies other than those specified by Spacelabs Healthcare may degrade equipment performance, including defibrillation protection.

Input leakage current for all patient input channels is less than 10 μA, making ECG units suitable for direct cardiac application. The maximum non-destructive voltage that can be applied to any input or output connector on the monitors, modules, or printers is +5 V. All signal inputs or outputs are for exclusive connection to 60601-1 medical equipment, or as specified by Spacelabs Healthcare.

Disposal of these devices and all accessories must be in accordance with local and federal laws.

<table>
<thead>
<tr>
<th>Product</th>
<th>Frequency</th>
<th>Electrical Rating</th>
<th>Fuse Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>90479-A/B/C</td>
<td>50/60 Hz</td>
<td>2 A/115 VAC 1 A/230-240 VAC</td>
<td>2-T2.5 A/250 V (Slow)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2-T1.6 A/250 V</td>
</tr>
<tr>
<td>90486</td>
<td>50/60 Hz</td>
<td>1.2 A/100-120 VAC 0.6 A/220-240 VAC</td>
<td>2-T1.6 A/250 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2-T1.0 A/250 V</td>
</tr>
<tr>
<td>90491/90499/</td>
<td>50/60 Hz</td>
<td>100-240 VAC 2.0-1.0 A</td>
<td>not user-serviceable</td>
</tr>
<tr>
<td>91367/91369/</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>91370/91387/</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>91518</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90518</td>
<td>50/60 Hz</td>
<td>100-240 VAC 2.0-1.0 A</td>
<td>2-T1.0A /250 V</td>
</tr>
</tbody>
</table>
Product Specifications

Warning:
- To protect against electrical shock, proper grounding is essential.
- If the integrity of the external Protective Earth conductor is in doubt, the equipment must be operated from its internal power source (if applicable).

Power Cord
- Three-wire, 18-gauge, hospital grade
  - OR -
- Three-wire, 0.75 mm², European harmonized

Plug
- Three-terminal polarized, with protective ground

Warning:
- Do not use a 3-to-2 plug adapter.
- Ground terminal of the plug is connected directly to the frame of the instrument. Any interruption of the grounding connector can create an electric shock hazard.

Note:
All of the products listed in Table 1 include battery backup to ensure that patient information is not lost in the event of a short-term power interruption lasting up to three minutes. Battery powered monitors also provide another layer of electrical security, because they will automatically switch to battery power if main power fails. The integrity of all patient data and the current monitor status is protected as long as the battery charge persists.

Equipment Classification

All equipment with patient-applied parts are Type BF or Type CF defibrillator-proof. Refer to Appendix A — Symbols on page A-1 for type definitions.

Table 2: Equipment Classification—Monitors and Housings

<table>
<thead>
<tr>
<th>Model</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>91367/91369/91370</td>
<td>Class I; grounded outlet; internally powered</td>
</tr>
<tr>
<td>91387</td>
<td>Class I; grounded outlet</td>
</tr>
<tr>
<td>90491</td>
<td>Class I; grounded outlet</td>
</tr>
<tr>
<td>90499</td>
<td>Class I; grounded outlet</td>
</tr>
<tr>
<td>90479-A/B/C</td>
<td>Class I; grounded outlet</td>
</tr>
</tbody>
</table>
Corrective or maintenance procedures must be performed by qualified personnel.

**Periodic maintenance procedures are required every 12 months to verify the following:**

- Equipment is physically sound.
- Resistance between the chassis ground connector on the rear panel and the protective ground of the mains input is not greater than 0.1 ohm.
- Isolation resistance between ground and mains is greater than 2 meg-ohm.

**While the equipment is operating normally, verify the following:**

- Chassis leakage current is less than 100 μA.
- Patient leakage current is less than 10 μA (Type CF) or 100 μA (Types B and BF).

**While the equipment is operating in single fault condition, verify the following:**

- Chassis leakage current is less than 300 μA (100 to 120 V) or 500 μA (220 to 240 V).
- Patient leakage current is less than 50 μA (Type CF) or 500 μA (Types B and BF).

Under non-optimal environmental conditions or periods of intense use, more frequent checks are recommended.

---

**Table 3: Equipment Classification—Modules**

<table>
<thead>
<tr>
<th>Model</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>90341/43/47</td>
<td>Type BF defibrillator-proof</td>
</tr>
<tr>
<td>90449/69</td>
<td>No patient-applied parts</td>
</tr>
<tr>
<td>90478</td>
<td>No patient-applied parts</td>
</tr>
<tr>
<td>90481</td>
<td>Type CF defibrillator-proof</td>
</tr>
<tr>
<td>91341/43/47</td>
<td>Type BF defibrillator-proof</td>
</tr>
<tr>
<td>91482</td>
<td>Type CF defibrillator-proof</td>
</tr>
<tr>
<td>91496</td>
<td>Type BF/CF defibrillator-proof</td>
</tr>
<tr>
<td>91517</td>
<td>Type BF defibrillator-proof</td>
</tr>
</tbody>
</table>

**Table 4: Equipment Classification—Other Equipment**

<table>
<thead>
<tr>
<th>Model</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>90310</td>
<td>No patient-applied parts</td>
</tr>
<tr>
<td>91518</td>
<td>Class I; grounded outlet Type BF defib proof</td>
</tr>
</tbody>
</table>
Product Specifications

Warning:

• Visually inspect all patient cables or sensors each time the unit is used. Check for worn or damaged plastic covering, frayed or broken wires, cracked connections, or any other signs of damage. Do not use cables or sensors which exhibit obvious damage.

• If the equipment is dropped, abused, or damaged in any way (if the monitor or module becomes wet, for example), a qualified field service engineer or biomedical engineer must verify that the unit is working correctly and that all safety features are intact.

Module Compatibility

If any function (NIBP, ECG, SpO₂, etc.) on your system does not contain a feature described in this manual:

• Your product may contain an earlier version of software. Contact a qualified service field engineer and refer to the original documentation that accompanied your system.

• Your system configuration may be different from that described in this manual. Refer to notes in this manual describing features where system configuration is likely to impact the available features.

Before moving a module from one network to another, be certain that the module software version is compatible with that required by the second network. If in doubt, have a qualified field service engineer verify compatibility between the module and the network.

Warnings and Cautions

The following warnings and cautions apply to the system or to multiple system components rather than to specific system components. Warnings and cautions that apply to specific components are located in the chapters describing those components.

Warnings

General

• Before use, carefully read the instructions, including all warnings and cautions.

• Inspect the monitor, sensor, cables, and connectors before each use. Do not use any equipment that appears damaged.

• Visually inspect all patient cables or sensors each time the unit is used. Check for worn or damaged plastic covering, frayed or broken wires, cracked connections, or any other signs of damage. Do not use cables or sensors which exhibit obvious damage.

• If the equipment is dropped, abused, or damaged in any way (if the monitor or module becomes wet, for example), a qualified field service engineer or biomedical engineer must verify that the unit is working correctly and that all safety features are intact.
Product Specifications

• Because of the potential for electromagnetic interference, electronic devices (for example, portable communication transmitters, cellular telephones, personal computers, electronic toys, and other medical devices) should not be operated within 3.5 feet (1.07 meters) of the patient, patient leads, or associated monitoring equipment until evaluated by the biomedical engineering staff.

• Shock hazards may exist if this instrument is not properly grounded. Protection against electrical shock is provided by grounding the chassis with a three-wire cable and plug. The grounding wire must not be removed or defeated. Grounding reliability can only be assured if connected to a receptacle marked Hospital Only or Hospital Grade.

• To reduce the risk of electric shock, do not remove the protective covers. Only qualified field service engineers should service the instrument.

• There is a risk of explosion if the instrument is operated in the presence of flammable anesthetics or any other flammable substance in combination with air, oxygen-enriched environments, or nitrous oxide.

• Always disconnect the instrument from the power supply prior to cleaning.

• Do not operate this instrument if it is wet or if condensation is present. Do not operate this instrument after exposure to extreme moisture, such as direct exposure to rain. If used while wet or when condensation is present, the monitor's performance may be inaccurate, or the monitor or its sensors or sensor cables may fail.

• The use of accessory equipment that does not comply with the monitor's safety requirements may lead to a reduced level of safety. Consideration should be given to the use of the accessory in the vicinity of a patient. The safety certification of the accessory must be performed in accordance with the appropriate IEC 60601-1 and/or IEC 60601-1-1 harmonized national standard.

• EMC compliance may be compromised by the connection of accessory and/or peripheral equipment. Compliance of accessory and/or peripheral equipment must be considered to ensure continued EMC compliance.

• Distorted parameter waveforms and erroneous numerical presentations may be seen if the monitor is exposed to a strong radio-frequency signal. If this occurs, ask a qualified service person to refer to the service manual's EMC appendix to help identify and resolve this electromagnetic interference (EMI).

• Systolic and diastolic pressures displayed numerically for patients being treated with an Intra-Aortic Balloon Pump (IABP) therapy may not be accurate. Display the waveform with scales to verify or determine pressures for these patients.

Alarms

• Alarm conditions for which you want to be alerted must be set to ON or enabled. You can enable them from the local bedside, remote bedside, or central monitor.

• To protect the patient’s safety, do not silence, suspend, or disable audible alarms without providing continuous, direct observation of the patient.

• Disabling alarm tones at a monitor eliminates alarm tones for all alarm conditions at that monitor, even in the case of life-threatening events.
Electrodes, Lead Wires, Sensors, and Sensor Cables

- Carefully route all cables between the patient and the monitor to reduce the possibility of patient entanglement or strangulation.

- Signals resulting from devices such as Implantable Cardiac Defibrillators (ICD) may momentarily blank the ECG waveform rather than display an out-of-range signal. In such cases it may not be apparent that the ICD has triggered and the condition of the patient should be checked. In all instances of the ICD being triggered, the monitor will redisplay the ECG waveform within five seconds.

- ECG alarms for ventricular fibrillation and asystole remain active while the patient's rate and morphology are being learned (for example, following a lead switch or use of the RELEARN feature). ECG alarms for high rate, low rate, run, couplet, abnormal/minute, and tachycardia are not reactivated until the learning process ends.

- Use only monitoring cables and safety lead wires to protect against accidental connection to electrical power cords or outlets. Failure to do so may result in adverse health consequences or death.

- To ensure against any possibility of electric shock, do not touch lead electrodes or the monitor during defibrillation.

Defibrillators, Pacemakers, and Electrosurgical Activity

- ECG detection circuitry may continue to count the pacing rate during occurrences of cardiac arrest or some arrhythmias. Do not rely entirely upon ECG rate alarms. Keep patients with pacemakers under close surveillance.

- The system may insert pacemaker flags into the ECG signal in response to signals that are not pacemaker pulses. Therefore, if you use a Spacelabs Healthcare monitor to observe pacemaker performance, you must take into account all possible sources of pacemaker flags.

- Use the pacemaker manufacturer's performance analyzer as the primary means of evaluating pacemaker operation.

- Some rate adaptive implanted pacemakers alter their rate based on the patient's Minute Volume. These pacemakers may occasionally be confused by the signal that a patient monitor uses to measure the patient's thoracic impedance (to determine respiration rate value). When this occurs, these pacemakers may begin pacing at their maximum programmed rate. Turning the RESP channel OFF can prevent this.

- While pacemakers are being programmed, the programming device may suppress the ECG waveform, preventing QRS detection and rate counting. This may result in an erroneous asystole alarm.

- Keep the monitor and its power cord and cables away from the electrosurgery unit and its associated cables and power cord.

- During electrosurgical activity, the system may not accurately detect pacemaker activity because of the electrical interference.
• **Signals resulting from devices such as Implantable Cardiac Defibrillators (ICD)** may momentarily blank the ECG waveform rather than display an out-of-range signal. In such cases it may not be apparent that the ICD has triggered, and the condition of the patient should be checked. **In all instances of the ICD being triggered, the monitor will redisplay the ECG waveform within five seconds.**

### Cautions

#### General

- Disposal of these devices and all accessories must be in accordance with local and federal laws.
- Detach all connectors and cables by grasping the connectors and pulling them straight out. Do not detach connectors and cables by pulling on the cables themselves.
- Status messages indicate a problem or condition which may affect accurate monitoring values. Do not ignore these messages. Correct any fault before continuing.

#### Electrodes and Lead Wires

- Visually inspect each lead wire for obvious damage and replace as needed.
- Use only patient cables and lead wires specified by Spacelabs Healthcare. Other cables and lead wires may degrade performance and may damage the monitor during defibrillation or high-frequency electrosurgery. Non-Spacelabs Healthcare cables and lead wires may also change the required input impedance and DC offset voltage, affecting monitor performance.
- Do not use stainless steel electrodes.
- Place the electrodes as far away from the electrosurgery site as possible, because significant high-frequency currents may flow into the electrodes. This can cause patient burns, especially if a defect is present in the neutral cable or return pad of the electrosurgical unit. Placing electrodes too close to the electrosurgery site can also result in noisy waveforms.
- Do not allow conductive parts of electrode leads or connectors, including the neutral electrode, to contact other conductive parts, including the ground.
Contents

Monitors, Modules, Cables, and Printers ................................................................. 1
Accessories ........................................................................................................... 2
TRU-CUFF® Noninvasive Blood Pressure Cuffs ................................................... 3

Monitors, Modules, Cables, and Printers

Cleaning/Disinfecting

Warning:

- Use only recommended cleaning solutions, or you may void the manufacturer’s warranty.
- Harsh chemical agents degrade plastics and will compromise the safety of the device. Some germicidal and other harsh cleaning compounds are known to damage some plastics by weakening the structural integrity and compromising the electrical insulating properties.
- Disconnect the equipment from the patient and the electrical supply before cleaning.
- Do not allow liquid to enter the interior of the module or monitoring equipment.
- Do not immerse the equipment or cables in water or cleaning solutions.
- Do not autoclave.

Caution:

Use caution when cleaning cable connectors so that liquid is not permitted to collect around the electrical contacts or seep inside the connector. Trapped liquids and surface residues provide an unintentional electrical path, which may cause noisy signals and false alarms.

To clean the exterior of monitors, modules, and cables:

- Prepare the cleaning solution according to the manufacturer’s instructions.
- Wet a clean cloth with the selected cleaning solution.
- Remove excess liquid from the cloth and squeeze dry.
- Wipe exposed surfaces of the equipment and cables.
- Remove any soap residue by gently wiping with a clean damp cloth.
- Wipe dry with a clean dry cloth.

Note:

After cleaning ECG lead wires, remove the ECG lead wires from the lead block and thoroughly dry them at the lead block ends and at the lead connector ends. Thorough drying will prevent residual moisture from providing a low-current path between leads, which can interfere with lead off detection and cause false asystoles.
Cleaning, Disinfecting, and Sterilization

Use only the following recommended cleaning solutions:

- Mild soap and water solution
- U.S. Pharmacopoeia (USP) green soap
- Sodium hypochlorite solution (1:10 dilution of household chlorine bleach in water)
- Phenolic germicidal detergent (1% aqueous solution)
- Glutaraldehyde (2.4%) (Cidex)
- Isopropyl alcohol (70% solution)

*Note:*

Over time, repeated use of a chlorine bleach solution may cause some colors to fade.

Tape adhesive can be removed with Spacelabs Healthcare adhesive tape remover pads (P/N 392196-001).

**Caution:**

Questions and concerns about cleaning issues should be directed to a Spacelabs Healthcare field service engineer.

**Touchscreen Cleaning**

Clean the touchscreen with a soft cloth moistened with either 70% isopropyl alcohol solution or soapy water.

*Note:*

- Follow your hospital protocol for the handling of blood and body fluids.
- Do not allow liquid to enter the monitor.

**Accessories**

- Where provided, follow the manufacturers’ instructions concerning disposable and reusable supplies.
- As applicable, follow your hospital protocol concerning cleaning, disinfection, and/or sterilization of reusable supplies.

Use of patient cables, transducers, sensors, or supplies other than those specified by Spacelabs Healthcare may adversely affect monitor performance.
TRU-CUFF® Noninvasive Blood Pressure Cuffs

TRU-CUFF Reusable and Disposable Cuffs

The disposable cuff wrap is designed for single patient use. It is packaged non-sterile and cannot be soaked, rinsed, or sterilized.

The reusable cuff is packaged non-sterile. It may be cleaned and disinfected with an enzymatic detergent and 10% solution of household bleach (5.25% sodium hypochlorite).

Materials

- Enzymatic detergent such as ENZOL (US) or CEDEZYME (UK)
- 10% solution of household bleach (5.25% sodium hypochlorite) in distilled water
- Soft cloths or bristle brushes
- Spray bottles

Figure 24-1: TRU-CUFF reusable and disposable cuffs

1 Reusable cuffs
2 Disposable cuffs

Cuff Cleaning and Disinfection
Cleaning, Disinfecting, and Sterilization

Procedure

1. Prepare the enzymatic detergent and bleach solutions in separate bottles according to the manufacturer’s instructions.

2. Spray detergent liberally on cuff, allowing it to sit for one minute.

3. Remove detergent with a soft cloth. For persistent contamination, scrub with a soft bristled brush.

4. Rinse the cuff thoroughly with distilled water.

5. Spray bleach solution on the affected area until saturated. Allow the cuff to sit for five minutes.

6. Remove any excess solution with a soft cloth and rinse again with distilled water. Allow two hours for air drying at ambient temperature.

Note:

Make sure water does not enter the hose connector.

ABP Cuffs

Refer to the 90207/90217 Ambulatory Blood Pressure Monitors, Operations Manual (P/N 070-0137-xx) for cleaning instructions related to ABP cuffs and monitor.
## Diagnostic Messages

<table>
<thead>
<tr>
<th>Message</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unable to support a new module at this time</td>
<td>Insufficient memory to support a new module. Unplug modules to free memory.</td>
</tr>
<tr>
<td>Unable to support a new channel at this time</td>
<td>Insufficient memory to support a new channel. Detach channels to free memory.</td>
</tr>
<tr>
<td>Diagnostic error encountered loading module</td>
<td>Checksum error detected loading module. Restart the monitor.</td>
</tr>
<tr>
<td>Diagnostic error encountered loading channel</td>
<td></td>
</tr>
<tr>
<td>Out of memory — deleting hemo entry</td>
<td>Insufficient memory available to the application to complete the requested operation.</td>
</tr>
<tr>
<td>Out of memory — deleting resp entry</td>
<td></td>
</tr>
<tr>
<td>Out of memory — deleting oxy entry</td>
<td></td>
</tr>
<tr>
<td>Out of memory — deleting renal entry</td>
<td></td>
</tr>
<tr>
<td>Remote monitor not responding</td>
<td>Calcs timeout expired waiting for remote GDS response. Verify that the remote monitor is on the network and try again.</td>
</tr>
<tr>
<td>Error reading data</td>
<td>Bad return code from GDS on data read; GDS is possibly corrupt. Reboot the monitor.</td>
</tr>
<tr>
<td>Error storing data</td>
<td></td>
</tr>
<tr>
<td>Error deleting stored data</td>
<td></td>
</tr>
<tr>
<td>No trend data available</td>
<td>There is no trend data in GDS.</td>
</tr>
<tr>
<td>No other bed on the network has active parameters</td>
<td>This message is in response to a remote request. The monitor has determined that there are no beds on the network with active parameters; remote operations are not possible at this time.</td>
</tr>
<tr>
<td>There are no parameters active on this bed</td>
<td>The selected bed has no active parameters.</td>
</tr>
<tr>
<td>Parameter is not available to monitor</td>
<td>Failed attempt to attach to a channel.</td>
</tr>
<tr>
<td>Maximum number of parameters exceeded</td>
<td>Insufficient memory to support a new parameter.</td>
</tr>
</tbody>
</table>
## Diagnostic Messages

<table>
<thead>
<tr>
<th>Message</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Communications with remote monitor interrupted</strong></td>
<td>Lost connection to the remote monitor. Verify that the remote monitor is on the network and retry remote operation.</td>
</tr>
<tr>
<td><strong>This insertion will cause prior assignment to be lost</strong></td>
<td>The requested zone assignment will cause a previously assigned zone to be lost. Touch PREVIOUS MENU or NORMAL SCREEN to abort the operation.</td>
</tr>
<tr>
<td><strong>Remote bed select feature is in use by another application</strong></td>
<td>Remote Bed Select is in use by another application. Only one application may use this feature at one time. Touch the application using the Remote Bed Select feature, and then touch PREVIOUS MENU or NORMAL SCREEN to abort the selection. The feature will now be available for use.</td>
</tr>
<tr>
<td><strong>Unable to record the requested alarm channel(s)</strong></td>
<td>Unable to perform the requested operation. Verify that a recorder is selected and operational.</td>
</tr>
<tr>
<td><strong>Unable to record the requested channel(s)</strong></td>
<td></td>
</tr>
</tbody>
</table>

Ultraview SL2200 Operations Manual
Appendix A — Symbols

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

**Note:** Graphic elements of certain keys and symbols may vary between product lines.

- **HELP Key**
- **HELP (Explain Prior Screen) Key**
- **MONITOR SETUP Key**
- **REMOTE Key**
- **TRENDS Key**
- **RECORD Key**
- **Dynamic Network Access (DNA) Key**
- **SPECIAL FUNCTIONS Key**
- **NORMAL SCREEN Key**
### Appendix A — Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Save" /></td>
<td>SAVE Key</td>
</tr>
<tr>
<td><img src="image" alt="Network" /></td>
<td>No Network Connection</td>
</tr>
<tr>
<td><img src="image" alt="Connection" /></td>
<td>Network Connection</td>
</tr>
<tr>
<td><img src="image" alt="No Network" /></td>
<td>Do Not Connect to Network</td>
</tr>
<tr>
<td><img src="image" alt="ICS" /></td>
<td>No Connection to Intesys® Clinical Suite (ICS)</td>
</tr>
<tr>
<td><img src="image" alt="Compression" /></td>
<td>Compression</td>
</tr>
<tr>
<td><img src="image" alt="Magnifying" /></td>
<td>Magnifying Glass</td>
</tr>
<tr>
<td><img src="image" alt="File Cabinet" /></td>
<td>File Cabinet</td>
</tr>
<tr>
<td><img src="image" alt="List of Rooms" /></td>
<td>List of Rooms</td>
</tr>
<tr>
<td><img src="image" alt="Printer" /></td>
<td>Printer</td>
</tr>
<tr>
<td><img src="image" alt="Service Message" /></td>
<td>Service Message</td>
</tr>
<tr>
<td><img src="image" alt="Previous" /></td>
<td>PREVIOUS MENU Key</td>
</tr>
<tr>
<td><img src="image" alt="Home" /></td>
<td>HOME Key</td>
</tr>
<tr>
<td><img src="image" alt="Arrows" /></td>
<td>Arrows</td>
</tr>
</tbody>
</table>
### Appendix A — Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="On Direction" /></td>
<td>On Direction</td>
</tr>
<tr>
<td><img src="image" alt="ON" /></td>
<td>ON — Power Connection to Mains</td>
</tr>
<tr>
<td><img src="image" alt="ON" /></td>
<td>ON — Part of the Instrument Only</td>
</tr>
<tr>
<td><img src="image" alt="ON Position for Push Button Power Switch" /></td>
<td>ON Position for Push Button Power Switch</td>
</tr>
<tr>
<td><img src="image" alt="OFF" /></td>
<td>OFF — Power Disconnection from Mains</td>
</tr>
<tr>
<td><img src="image" alt="OFF" /></td>
<td>OFF Position for Push Button Power Switch</td>
</tr>
<tr>
<td><img src="image" alt="OFF" /></td>
<td>OFF — Part of the Instrument Only</td>
</tr>
<tr>
<td><img src="image" alt="Partial ON/OFF" /></td>
<td>Partial ON/OFF</td>
</tr>
<tr>
<td><img src="image" alt="ON/OFF" /></td>
<td>ON/OFF</td>
</tr>
<tr>
<td><img src="image" alt="Standby" /></td>
<td>Standby</td>
</tr>
</tbody>
</table>
| ![STANDBY Key](image) | STANDBY Key  
Power ON/OFF Key |
<p>| <img src="image" alt="Keyboard Connection" /> | Keyboard Connection |
| <img src="image" alt="Mouse Connection" /> | Mouse Connection |
| <img src="image" alt="PAUSE or INTERRUPT" /> | PAUSE or INTERRUPT |
| <img src="image" alt="START/STOP Key" /> | START/STOP Key |</p>
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>![START/STOP]</td>
<td>START/STOP</td>
</tr>
<tr>
<td>![STOP or CANCEL Key]</td>
<td>STOP or CANCEL Key</td>
</tr>
<tr>
<td>![CONTINUE Key]</td>
<td>CONTINUE Key</td>
</tr>
<tr>
<td>![ENTER Key]</td>
<td>ENTER Key</td>
</tr>
<tr>
<td>![Delete]</td>
<td>Delete</td>
</tr>
<tr>
<td>![Nurse Alert Interface]</td>
<td>Nurse Alert Interface</td>
</tr>
<tr>
<td>![ALARM SUSPEND/TONE RESET Key]</td>
<td>ALARM SUSPEND/TONE RESET Key</td>
</tr>
<tr>
<td>![ALARMS Key]</td>
<td>ALARMS Key</td>
</tr>
<tr>
<td>![Alarm, General]</td>
<td>Alarm, General</td>
</tr>
<tr>
<td>![Alarm Reset]</td>
<td>Alarm Reset</td>
</tr>
<tr>
<td>![Alarm Audio ON]</td>
<td>Alarm Audio ON</td>
</tr>
<tr>
<td>![Alarm Audio OFF]</td>
<td>Alarm Audio OFF</td>
</tr>
<tr>
<td>![Alarm Audio Paused]</td>
<td>Alarm Audio Paused</td>
</tr>
<tr>
<td>![Low Priority Alarm]</td>
<td>Low Priority Alarm</td>
</tr>
<tr>
<td>![Medium Priority Alarm]</td>
<td>Medium Priority Alarm</td>
</tr>
</tbody>
</table>
## Appendix A — Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>🚨</td>
<td>High Priority Alarm</td>
</tr>
<tr>
<td>🚫</td>
<td>Alarms Paused</td>
</tr>
<tr>
<td>⚫</td>
<td>Alarm OFF</td>
</tr>
<tr>
<td>☹️</td>
<td>Parameter below measurement range</td>
</tr>
<tr>
<td>+++</td>
<td>Parameter above measurement range</td>
</tr>
<tr>
<td>???</td>
<td>Parameter measurement indeterminate</td>
</tr>
<tr>
<td>🔄</td>
<td>Indicator — Remote Control</td>
</tr>
<tr>
<td>📄</td>
<td>PRINT REPORT Key</td>
</tr>
<tr>
<td>🏛️</td>
<td>Normal Screen</td>
</tr>
<tr>
<td>⌚️</td>
<td>Clock/Time Setting Key</td>
</tr>
<tr>
<td>✅</td>
<td>Slow Run</td>
</tr>
<tr>
<td>📠</td>
<td>Activate Recorder for Graphics</td>
</tr>
<tr>
<td>⏰</td>
<td>Reset</td>
</tr>
<tr>
<td>🔴</td>
<td>START (NIBP) Key</td>
</tr>
</tbody>
</table>
## Appendix A — Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td><img src="image" alt="Power Indicator LED" /></td>
<td>Power Indicator LED</td>
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<tr>
<td><img src="image" alt="Activate Telemetry Recorder" /></td>
<td>Activate Telemetry Recorder</td>
</tr>
<tr>
<td><img src="image" alt="Output (Non-terminated)" /></td>
<td>Output (Non-terminated)</td>
</tr>
<tr>
<td><img src="image" alt="Data Input/Output" /></td>
<td>Data Input/Output</td>
</tr>
<tr>
<td><img src="image" alt="Input" /></td>
<td>Input</td>
</tr>
<tr>
<td><img src="image" alt="No Output (Terminated)" /></td>
<td>No Output (Terminated)</td>
</tr>
<tr>
<td><img src="image" alt="Indicator — Local Control" /></td>
<td>Indicator — Local Control</td>
</tr>
<tr>
<td><img src="image" alt="Indicator — Out of Paper" /></td>
<td>Indicator — Out of Paper</td>
</tr>
<tr>
<td><img src="image" alt="Recorder Paper" /></td>
<td>Recorder Paper</td>
</tr>
<tr>
<td><img src="image" alt="Menu Keys" /></td>
<td>Menu Keys</td>
</tr>
<tr>
<td><img src="image" alt="Waveform/Parameter Keys" /></td>
<td>Waveform/Parameter Keys</td>
</tr>
<tr>
<td><img src="image" alt="Return to Prior Menu" /></td>
<td>Return to Prior Menu</td>
</tr>
<tr>
<td><img src="image" alt="Monitor Setup" /></td>
<td>Monitor Setup</td>
</tr>
<tr>
<td><img src="image" alt="Select Program Options" /></td>
<td>Select Program Options</td>
</tr>
<tr>
<td><img src="image" alt="Set Initial Conditions Menu" /></td>
<td>Set Initial Conditions Menu</td>
</tr>
</tbody>
</table>
## Appendix A — Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td>Access Special Function Menu</td>
</tr>
<tr>
<td><img src="image2.png" alt="Image" /></td>
<td>Return Unit to Monitor Mode</td>
</tr>
<tr>
<td><img src="image3.png" alt="Image" /></td>
<td>Keypad</td>
</tr>
<tr>
<td><img src="image4.png" alt="Image" /></td>
<td>Serial Port 1</td>
</tr>
<tr>
<td><img src="image5.png" alt="Image" /></td>
<td>Serial Port 2</td>
</tr>
<tr>
<td><img src="image6.png" alt="Image" /></td>
<td>Serial Port</td>
</tr>
<tr>
<td><img src="image7.png" alt="Image" /></td>
<td>Auto Mode (NIBP)</td>
</tr>
<tr>
<td><img src="image8.png" alt="Image" /></td>
<td>External Marker Push Button Connection</td>
</tr>
<tr>
<td><img src="image9.png" alt="Image" /></td>
<td>Arterial Pulse</td>
</tr>
<tr>
<td><img src="image10.png" alt="Image" /></td>
<td>Gas Exhaust</td>
</tr>
<tr>
<td><img src="image11.png" alt="Image" /></td>
<td>Video Output</td>
</tr>
<tr>
<td><img src="image12.png" alt="Image" /></td>
<td>Television; Video Display</td>
</tr>
<tr>
<td><img src="image13.png" alt="Image" /></td>
<td>Video Output, Primary</td>
</tr>
<tr>
<td><img src="image14.png" alt="Image" /></td>
<td>Video Output, Secondary</td>
</tr>
</tbody>
</table>
Appendix A — Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td></td>
<td>Enlarge, Zoom</td>
</tr>
<tr>
<td></td>
<td>Input/Output</td>
</tr>
<tr>
<td></td>
<td>PCMCIA Card</td>
</tr>
<tr>
<td></td>
<td>Touchscreen, External</td>
</tr>
<tr>
<td></td>
<td>Universal Serial Bus</td>
</tr>
<tr>
<td></td>
<td>SDLC Port</td>
</tr>
<tr>
<td></td>
<td>Hard Drive</td>
</tr>
<tr>
<td></td>
<td>Antenna</td>
</tr>
<tr>
<td></td>
<td>Electrocardiograph or Defibrillator Synchronization</td>
</tr>
<tr>
<td></td>
<td>Microphone</td>
</tr>
<tr>
<td></td>
<td>Foot Switch</td>
</tr>
<tr>
<td></td>
<td>Audio Output, Speaker</td>
</tr>
<tr>
<td></td>
<td>Event</td>
</tr>
<tr>
<td></td>
<td>Gas Sampling Port</td>
</tr>
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### Appendix A — Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td><img src="image" alt="Gas Return Port" /></td>
<td>Gas Return Port</td>
</tr>
<tr>
<td><img src="image" alt="Battery" /></td>
<td>Battery&lt;br&gt;Replace only with the appropriate battery.</td>
</tr>
<tr>
<td><img src="image" alt="Battery Status" /></td>
<td>Battery Status</td>
</tr>
<tr>
<td><img src="image" alt="Low Battery" /></td>
<td>Battery&lt;br&gt;Replace only with the appropriate battery.</td>
</tr>
<tr>
<td><img src="image" alt="Replace only with the appropriate battery." /></td>
<td>Replace only with the appropriate battery.&lt;br&gt;(+ / - signs may be reversed)</td>
</tr>
<tr>
<td><img src="image" alt="All batteries should be disposed of properly to protect the environment. Lithium batteries should be fully discharged before disposal. Batteries such as lead-acid (Pb) and nickel-cadmium (Ni-Cd) must be recycled. Please follow your internal procedures and or local (provincial) laws regarding disposal or recycling." /></td>
<td>All batteries should be disposed of properly to protect the environment. Lithium batteries should be fully discharged before disposal. Batteries such as lead-acid (Pb) and nickel-cadmium (Ni-Cd) must be recycled. Please follow your internal procedures and or local (provincial) laws regarding disposal or recycling.</td>
</tr>
<tr>
<td><img src="image" alt="This symbol indicates that the waste of electrical and electronic equipment must not be disposed as unsorted municipal waste and must be collected separately. Please contact an authorized representative of the manufacturer for information concerning the decommissioning of your equipment." /></td>
<td>This symbol indicates that the waste of electrical and electronic equipment must not be disposed as unsorted municipal waste and must be collected separately. Please contact an authorized representative of the manufacturer for information concerning the decommissioning of your equipment.</td>
</tr>
<tr>
<td><img src="image" alt="Caution - hazardous voltages. To reduce risk of electric shock, do not remove the cover or back. Refer servicing to a qualified field service engineer (U.S.A.). DANGER - High Voltage (International)" /></td>
<td>Caution - hazardous voltages. To reduce risk of electric shock, do not remove the cover or back. Refer servicing to a qualified field service engineer (U.S.A.). DANGER - High Voltage (International)</td>
</tr>
<tr>
<td><img src="image" alt="Protective Earth Ground" /></td>
<td>Protective Earth Ground</td>
</tr>
<tr>
<td><img src="image" alt="Replace Fuse Only as Marked" /></td>
<td>Replace Fuse Only as Marked</td>
</tr>
<tr>
<td><img src="image" alt="Power supply jack polarity. (+ / - signs may be reversed)" /></td>
<td>Power supply jack polarity.&lt;br&gt;(+ / - signs may be reversed)</td>
</tr>
<tr>
<td><img src="image" alt="Alternating Current" /></td>
<td>Alternating Current</td>
</tr>
<tr>
<td><img src="image" alt="Both Direct and Alternating Current" /></td>
<td>Both Direct and Alternating Current</td>
</tr>
</tbody>
</table>
### Appendix A — Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td><img src="image" alt="Functional Earth Ground" /></td>
<td>Functional Earth Ground</td>
</tr>
<tr>
<td><img src="image" alt="Fuse" /></td>
<td>Fuse</td>
</tr>
<tr>
<td><img src="image" alt="Equipotentiality Terminal" /></td>
<td>Equipotentiality Terminal</td>
</tr>
<tr>
<td><img src="image" alt="Direct Current" /></td>
<td>Direct Current</td>
</tr>
<tr>
<td><img src="image" alt="Input Power" /></td>
<td>Input Power. Use only Spacelabs Power Supply (P/N 119-0527-xx).</td>
</tr>
<tr>
<td><img src="image" alt="AC/DC Input" /></td>
<td>AC/DC Input</td>
</tr>
<tr>
<td><img src="image" alt="Loop Filter" /></td>
<td>Loop Filter</td>
</tr>
<tr>
<td><img src="image" alt="Audio Output, Speaker" /></td>
<td>Audio Output, Speaker</td>
</tr>
<tr>
<td><img src="image" alt="IEC 60601-1 Type B equipment" /></td>
<td>IEC 60601-1 Type B equipment. The unit displaying this symbol contains an adequate degree of protection against electric shock.</td>
</tr>
<tr>
<td><img src="image" alt="IEC 60601-1 Type BF equipment" /></td>
<td>IEC 60601-1 Type BF equipment which is defibrillator-proof. The unit displaying this symbol is an F-type isolated (floating) patient-applied part which contains an adequate degree of protection against electric shock, and is defibrillator-proof.</td>
</tr>
<tr>
<td><img src="image" alt="IEC 60601-1 Type CF equipment" /></td>
<td>IEC 60601-1 Type CF equipment. The unit displaying this symbol is an F-type isolated (floating) patient-applied part providing a high degree of protection against electric shock, and is defibrillator-proof.</td>
</tr>
<tr>
<td><img src="image" alt="IEC 60601-1 Class II equipment" /></td>
<td>IEC 60601-1 Class II equipment, double-isolated. The unit displaying this symbol does not require a grounded outlet.</td>
</tr>
</tbody>
</table>
Appendix A — Symbols

Warning: Do not modify this equipment without authorization of the manufacturer.

Operates on Non-Harmonized Radio Frequencies in Europe

Adult Noninvasive Blood Pressure (NIBP)

Fetal Monitor Connection (Analog)

Fetal Monitor Connection RS-232 (Digital)

Physiological Monitor Connection RS-232 (Digital)

Noninvasive Blood Pressure (NIBP),

Symbol Set, Adult/Pediatric Cuff Sizes

Symbol Set, Neonatal Cuff Sizes

NIBP Cuff, Neonatal 1

NIBP Cuff, Neonatal 2

NIBP Cuff, Neonatal 3

NIBP Cuff, Neonatal 4
## Appendix A — Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Symbol" /></td>
<td>NIBP Cuff, Neonatal 5</td>
</tr>
<tr>
<td><img src="image2" alt="Symbol" /></td>
<td>NIBP Cuff, Single Hose</td>
</tr>
<tr>
<td><img src="image3" alt="Symbol" /></td>
<td>NIBP Cuff, Dual Hose</td>
</tr>
<tr>
<td><img src="image4" alt="Symbol" /></td>
<td>NIBP Cuff, Surface Applied to Patient</td>
</tr>
<tr>
<td><img src="image5" alt="Symbol" /></td>
<td>NIBP Cuff, Child Size (12 to 19 cm)</td>
</tr>
<tr>
<td><img src="image6" alt="Symbol" /></td>
<td>NIBP Cuff, Child Size, Long (12 to 19 cm)</td>
</tr>
<tr>
<td><img src="image7" alt="Symbol" /></td>
<td>NIBP Cuff, Small Adult Size, Long (17 to 25 cm)</td>
</tr>
<tr>
<td><img src="image8" alt="Symbol" /></td>
<td>NIBP Cuff, Small Adult Size (17 to 25 cm)</td>
</tr>
<tr>
<td><img src="image9" alt="Symbol" /></td>
<td>NIBP Cuff, Adult Size, Long (23 to 33 cm)</td>
</tr>
<tr>
<td><img src="image10" alt="Symbol" /></td>
<td>NIBP Cuff, Large Adult Size, Long (31 to 40 cm)</td>
</tr>
<tr>
<td><img src="image11" alt="Symbol" /></td>
<td>NIBP Cuff, Large Adult Size (31 to 40 cm)</td>
</tr>
<tr>
<td><img src="image12" alt="Symbol" /></td>
<td>NIBP Cuff, Adult Size (23 to 33 cm)</td>
</tr>
<tr>
<td><img src="image13" alt="Symbol" /></td>
<td>NIBP Cuff, Infant Size (8 to 13 cm)</td>
</tr>
<tr>
<td><img src="image14" alt="Symbol" /></td>
<td>NIBP Cuff, Neonatal 1 Size (3 to 6 cm)</td>
</tr>
</tbody>
</table>
### Appendix A — Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td>NEONATAL 2</td>
<td>NIBP Cuff, Neonatal 2 Size (4 to 8 cm)</td>
</tr>
<tr>
<td>NEONATAL 3</td>
<td>NIBP Cuff, Neonatal 3 Size (6 to 11 cm)</td>
</tr>
<tr>
<td>NEONATAL 4</td>
<td>NIBP Cuff, Neonatal 4 Size (7 to 13 cm)</td>
</tr>
<tr>
<td>NEONATAL 5</td>
<td>NIBP Cuff, Neonatal 5 Size (8 to 15 cm)</td>
</tr>
<tr>
<td>THIGH</td>
<td>NIBP Cuff, Thigh Size (38-50 cm)</td>
</tr>
<tr>
<td>NYLON</td>
<td>NIBP Cuff, Nylon Material</td>
</tr>
<tr>
<td>SOFT</td>
<td>NIBP Cuff, Soft Material</td>
</tr>
<tr>
<td>VINYL</td>
<td>NIBP Cuff, Vinyl Material</td>
</tr>
<tr>
<td>QTY</td>
<td>Quantity</td>
</tr>
<tr>
<td>ARTERY</td>
<td>Place Artery Symbol and Arrow over Brachial or Femoral Artery</td>
</tr>
<tr>
<td>eIFU indicator</td>
<td>eIFU = electronic Instructions for Use (CD-ROM or website) is available</td>
</tr>
<tr>
<td>Follow Instructions For Use</td>
<td></td>
</tr>
<tr>
<td>Warning</td>
<td>Warning About Potential Danger to Human Beings (Consult Accompanying Documents)</td>
</tr>
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</table>
# Appendix A — Symbols

<table>
<thead>
<tr>
<th>Caution</th>
<th>Caution About Potential Danger to a Device (Consult Accompanying Documents)</th>
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<td><img src="image" alt="Caution Symbol" /></td>
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<table>
<thead>
<tr>
<th>Note</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Note Symbol" /></td>
<td></td>
</tr>
</tbody>
</table>

| Keep Dry | |
|----------||
| ![Keep Dry Symbol](image) | | |

| Indoor Use Only | |
|-----------------||
| ![Indoor Use Only Symbol](image) | | |

<table>
<thead>
<tr>
<th>Environmental Shipping/Storage Altitude Limitations</th>
</tr>
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<tbody>
<tr>
<td><img src="image" alt="Environmental Shipping/Storage Altitude Limitations Symbol" /></td>
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<table>
<thead>
<tr>
<th>Environmental Shipping/Storage Temperature Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Environmental Shipping/Storage Temperature Limitations Symbol" /></td>
</tr>
</tbody>
</table>

| Fragile; Handle with Care | |
|---------------------------||
| ![Fragile; Handle with Care Symbol](image) | | |

| This Way Up | |
|-------------||
| ![This Way Up Symbol](image) | | |

| Up Arrow | |
|----------||
| ![Up Arrow Symbol](image) | | |

| Down Arrow | |
|------------||
| ![Down Arrow Symbol](image) | | |

<table>
<thead>
<tr>
<th>Environmental Shipping/Storage Humidity Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Environmental Shipping/Storage Humidity Limitations Symbol" /></td>
</tr>
</tbody>
</table>

| Open Padlock | |
|--------------||
| ![Open Padlock Symbol](image) | | |

| Closed Padlock | |
|----------------||
| ![Closed Padlock Symbol](image) | | |

| Happy Face | |
|------------||
| ![Happy Face Symbol](image) | | |
## Appendix A — Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>😞</td>
<td>Sad Face</td>
</tr>
<tr>
<td>PVC</td>
<td>PVC-Free (Polyvinyl Chloride)</td>
</tr>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>Do Not Reuse; Single Use Only</td>
</tr>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>Reusable</td>
</tr>
<tr>
<td>IPX1</td>
<td>Drip-Proof</td>
</tr>
<tr>
<td>IPX7</td>
<td>Unit can withstand accidental immersion in one meter of water for up to 30 minutes</td>
</tr>
<tr>
<td>REF</td>
<td>Reference Number or Order Number</td>
</tr>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>Use by date [YYYY-MM-DD]</td>
</tr>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>Recycle</td>
</tr>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>Non Sterile</td>
</tr>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>Latex-Free</td>
</tr>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>Date of Manufacture</td>
</tr>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>Manufacturer</td>
</tr>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>Radio transmitting device; elevated levels of non-ionizing radiation</td>
</tr>
</tbody>
</table>
### Appendix A — Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>CE</td>
<td>A CE mark certifies that a product has met EU health, safety, and environmental requirements, which ensure consumer safety.</td>
</tr>
<tr>
<td>XXXX</td>
<td>XXXX is the European Notified Body number. 0123 is the number for TÜV SÜD Product Service GmbH, München, Germany.</td>
</tr>
<tr>
<td>C</td>
<td>Canadian Standards Association Approved</td>
</tr>
<tr>
<td>LOT</td>
<td>Batch Code</td>
</tr>
<tr>
<td>NE 2</td>
<td>Nellcor Oxisensor II Compatible</td>
</tr>
<tr>
<td>NV X</td>
<td>Novametrix Compatible</td>
</tr>
<tr>
<td>TruLink*</td>
<td>Spacelabs TruLink Compatible</td>
</tr>
<tr>
<td>OxiMax</td>
<td>Nellcor OxiMax Compatible</td>
</tr>
<tr>
<td></td>
<td>Spacelabs Compatible</td>
</tr>
<tr>
<td></td>
<td>UL recognized component in Canada and United States</td>
</tr>
<tr>
<td></td>
<td>Nellcor OxiMax Compatible</td>
</tr>
<tr>
<td></td>
<td>Masimo SET Compatible</td>
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</table>
### Appendix A — Symbols

**Abbreviations used as symbols are shown below.**

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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>1 - 32</td>
<td>Access Codes 1 Through 32</td>
</tr>
<tr>
<td>AIR</td>
<td>Air</td>
</tr>
<tr>
<td>A</td>
<td>Amperes</td>
</tr>
<tr>
<td>ANT 1</td>
<td>Diversity Antenna System 1</td>
</tr>
<tr>
<td>ANT 2</td>
<td>Diversity Antenna System 2</td>
</tr>
<tr>
<td>Arr1</td>
<td>Arrhythmia Net 1</td>
</tr>
<tr>
<td>ArrNet2</td>
<td>Arrhythmia Net 2</td>
</tr>
<tr>
<td>avDO₂</td>
<td>Arterial/Venous Oxygen Difference</td>
</tr>
<tr>
<td>CaO₂</td>
<td>Arterial Oxygen</td>
</tr>
<tr>
<td>CH</td>
<td>EEG, EMG, or ECG Channel</td>
</tr>
<tr>
<td>ch</td>
<td>EEG Channels - CH1, CH2, CH3, CH4</td>
</tr>
<tr>
<td></td>
<td>EMG Channel - CH5</td>
</tr>
<tr>
<td>cmH₂O</td>
<td>Centimeters of Water</td>
</tr>
<tr>
<td>C.O. CO</td>
<td>Cardiac Output</td>
</tr>
<tr>
<td>CvO₂</td>
<td>Venous Oxygen</td>
</tr>
<tr>
<td>CO₂</td>
<td>Carbon Dioxide</td>
</tr>
<tr>
<td>Dia</td>
<td>Diastolic</td>
</tr>
<tr>
<td>ECG ecg</td>
<td>Electrocardiogram</td>
</tr>
<tr>
<td>EEG eeg</td>
<td>Electroencephalogram</td>
</tr>
<tr>
<td>EMG emg</td>
<td>Electromyogram</td>
</tr>
<tr>
<td>ESIS</td>
<td>Electrosurgical Interference Suppression</td>
</tr>
<tr>
<td>EXT</td>
<td>External</td>
</tr>
<tr>
<td>FECG</td>
<td>Fetal Electrocardiogram</td>
</tr>
<tr>
<td>FHR1 FHR2</td>
<td>Fetal Heart Rate, Channel 1 Fetal Heart Rate, Channel 2</td>
</tr>
<tr>
<td>GND gnd</td>
<td>Ground</td>
</tr>
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## Appendix A — Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Hz</td>
<td>Hertz</td>
</tr>
<tr>
<td>Hgb</td>
<td>Hemoglobin</td>
</tr>
<tr>
<td>HLO</td>
<td>High-Level Output</td>
</tr>
<tr>
<td>hlo</td>
<td></td>
</tr>
<tr>
<td>Multiview</td>
<td>Multi-Lead Electrocardiogram</td>
</tr>
<tr>
<td>N₂O</td>
<td>Nitrous Oxide</td>
</tr>
<tr>
<td>NIBP</td>
<td>Noninvasive Blood Pressure</td>
</tr>
<tr>
<td>nibp</td>
<td></td>
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## Appendix A — Symbols

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