
NorthEast Monitoring Inc. Holter LX Enhanced/ Enhanced Plus Software

Operator's Manual

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authors of iText library. This open source library provided the ability
to generate Adobe Acrobat files. For more information, see
www.lowagie.com/iText.**

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1 INTRODUCTION TO LX ENHANCED/ ENHANCED PLUS

Welcome to NorthEast Monitoring's Holter LX Enhanced/Enhanced Plus Software. Used in conjunction with a NorthEast Monitoring Digital Holter Recorder (either the DR180+ or the SD360), LX Enhanced allows you to fully review all of the ECG recorded during the Holter test, including all normal, ventricular, supraventricular, and paced beats, color-coded to indicate each label. You can quickly review and edit significant arrhythmic events, strips saved for the printed report, data trends, and tables. You can also review and edit all report information before it's printed, then print whatever pages are required to document each patient's Holter test. In addition, LX Enhanced automatically reads patient data from the recorder's flashcard/SD card - including entries made using the Event button - and saves sample strips of event markers and diary entries. Backup features, remote reporting, and spectral analysis are also included. Optional oximetry and 12-lead data from the DR180+ can also be analyzed, edited, and presented.

CAUTION: Federal law restricts this device to sale by or on the order of a physician.

Note: This product, like all Holter monitoring products, should be used only under the direct supervision of a licensed physician.

NorthEast Monitoring is an FDA Registered Facility (1224919) that follows all FDA CGMP Manufacturing Practices. The DR180+ Digital Recorder with oximetry and the Holter LX oximetry software has FDA 510K Approved Product Certification (K004007). The Holter LX software has FDA 510K Approved Product Certification (K930564).

Package contents

Your Holter LX Enhanced/Enhanced Plus package includes:

- NorthEast Monitoring Holter LX software CD
- NorthEast Holter LX Enhanced Software Operator's Manual
- NorthEast Monitoring Software Protection Key
- NorthEast Monitoring Registration Number
- Installation instructions

System requirements

This software can only be used in conjunction with a NorthEast Monitoring Digital Recorder - either the DR180+ or SD360. It is not compatible with the Holter monitor of any other manufacturer. To run the Holter LX Enhanced software, your personal computer must include:

- Microsoft Windows XP
- a processor with a speed of 1 GHz or faster
- at least 256 MB of memory; 512 MB is recommended
- a disk drive of at least 10 GB
- a monitor with a resolution of at least 1024 by 768
- a USB compact flashcard/SD card reader or a laptop PC card slot
- a laser printer is recommended

Operator knowledge

To use NorthEast Monitoring Holter LX Enhanced/Enhanced Plus Software, you must have extensive Holter knowledge that allows you to properly identify sinus and paced rhythms, abnormal rhythms, supraventricular and ventricular arrhythmias, artifact, ST segment changes, and pacemaker failures. In addition, all instructions assume a working knowledge of computers and, specifically, Windows XP software.

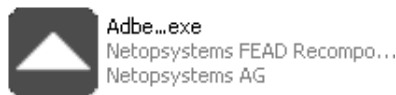
Installation instructions

To run, Holter LX Enhanced/Enhanced Plus software must be installed on your hard disk. We recommend that no other Windows programs be running when you install the Holter LX Enhanced software. To install the Holter LX software:

1. Insert the NorthEast Holter LX Software CD into your computer's CD drive. A window opens on your monitor acknowledging the CD and displaying icons indicating what is present on the CD. They include one for Adobe Acrobat Reader (its label starts "Adbe"), one for Java 2 Runtime Environment (its label starts "j2re"), one for the Rainbow key that is specific to your system (its label starts "rainbow"), and one for NorthEast Holter LX (its label starts "nem"). In addition, there are document files containing a copy of this and other NorthEast product operator's manuals, and a "readme"

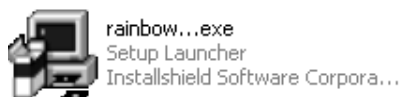
text file. (We recommend that you print and read the readme file as soon as installation is complete.)

2. Double click on the Adobe Acrobat Reader icon and follow the installation instructions as they appear on the screen, pressing the Enter key whenever prompted to go to the Next window. When completed, the CD window re-appears.



Acrobat Reader icon

3. If your NorthEast software key (a.k.a. dongle) is already plugged into one of the ports on your computer, remove it. A software key for a parallel port is putty-colored, and one for a USB port is purple.

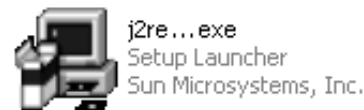


Rainbow icon

With the software key removed, double click on the Rainbow icon and follow the installation instructions as they appear on the screen, pressing the Enter key whenever prompted to go to the Next window. When completed, the CD window re-appears. Plug the software key into the appropriate port.

Note: If you are asked to reboot after Rainbow installation, please reboot and then continue with step 4.

4. Double click on the Java icon and

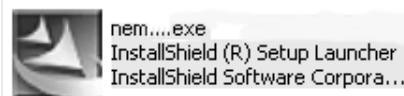


Java icon

follow the installation instructions as they appear on the screen, pressing the Enter key whenever prompted to go to the Next window. When completed, the CD window re-appears.

Note: If you are asked to reboot after Java installation, please reboot and continue with step 5.

5. Double click on the NorthEast icon and follow the installations instructions as they appear on the screen. Each time you are prompted to go to



NorthEast Monitoring icon

the Next instruction window, press the Enter key to do so. When you are prompted to select Finish, press the Enter key to do so. After a short delay, the Setup window opens.

6. Type appropriate information in each of the fields, including your

name and the name of your facility. In the five fields for the Report Heading, type the five lines you want to appear at the top of the front page of each Holter report. Leave the Number of patients set to 30. Click on the radio button next to “Digital recorder with a software key,” then carefully type your registration number in the Registration field. When the information is complete, click OK to close the Setup window.

The Setup window is a standard Windows-style dialog box. It has a title bar with 'Setup' and a close button. The main area contains several sections: 'Company' with a text field containing 'NorthEast Monitoring'; 'User name' with a text field containing 'NE'; 'Language' with a dropdown menu set to 'English'; 'Report heading' with five stacked text fields containing 'NorthEast Monitoring Inc.', 'Two Clock Tower, Suite 360', 'Maynard MA', and two empty fields; 'Number of patients' with a spin box set to '100'; 'Registration' with an empty text field; and 'Options' with three radio buttons: 'Digital recorder with a software key' (selected), 'Basic edition', and 'Demonstration system'. At the bottom are 'OK' and 'Cancel' buttons.

Setup window

7. Close the CD window. The Holter LX Enhanced/Enhanced Plus software launches and is ready to be used. To exit the Holter LX software, select Patient > Exit or click the red Close button in the upper right corner.

Launching LX Enhanced

Once the programs are installed, you start the Holter LX Enhanced/Enhanced Plus software by selecting Start > Programs > Holter 5 > Holter 5 from the Start menu.

If you use the LX Enhanced/Enhanced Plus Software often enough, Windows XP may add Holter 5 to the Start menu, and you can then start the Holter LX Enhanced software by selecting Start > Holter 5.

Online help

In addition to the information in this manual and the on-screen help messages that appear within the LX Enhanced/Enhanced Plus software, help is also available online at our web site www.nemon.com.

Inserting a compact flashcard/SD card

All ECG recorded during the Holter period is saved on a removable memory card. The DR180+ recorder uses a compact flashcard, while the SD360 recorder uses an SD memory card. To input the data from the card to the computer system, first remove the card from the recorder, and then insert it into your computer system's card reader.

Into a USB SD memory card reader

To insert an SD memory card into the drive, hold the card right-side up, with the missing corner away from you and to the right. Insert the opposite edge into the opening of the SD card reader. Push the card in gently until it is fully plugged in. Some card readers have a light indicating when a flashcard is properly inserted; if yours does, make sure the light comes on.

Depending on your computer and your card reader, a window may appear acknowledging that a card has been newly inserted and listing what files are present on the card. A recording saved by an SD360 Digital Recorder is named “flash.dat.” If the window appears, close it.

Into a USB compact flashcard reader

To insert the compact flashcard into the flashcard drive, hold onto the card by the edge with the ridge and insert the opposite edge into the opening of the flashcard reader. Push the card in gently until it is fully plugged in. Some card readers have a light indicating when a flashcard is properly inserted; if yours does, make sure the light comes on.

Depending on your computer and your card reader, a window may appear acknowledging that a card has been newly inserted and listing what files are present on the card. A recording saved by a DR180+ Digital

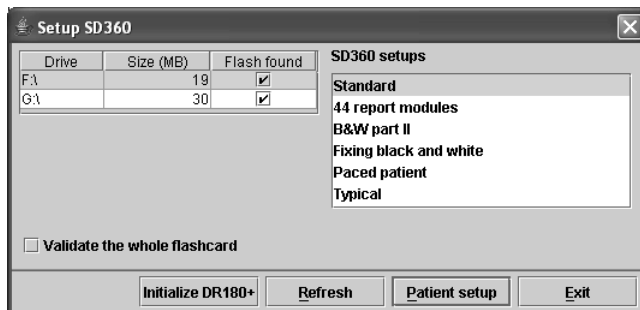
Recorder is named “flash.dat.” If the window appears, close it.

Into a laptop PC card slot

First insert the compact flashcard into a compact flashcard adaptor; to do so, hold onto the card by the edge with the ridge and insert the opposite edge into the adapter. Then insert the adaptor, right side up into the laptop’s card slot. If a window appears listing what files are on the flashcard, close it.

Formatting an SD memory card

To use an SD memory card with North-East Monitoring’s SD360 recorder, it must be initialized using the LX Holter software. To do so, insert the SD card into the card reader, close the Windows Explorer window that opens, and using the Holter software, select Patient > Flashcard > Initialize. The Setup SD360 window opens. It displays every drive that holds a memory card and a list of configurations (SD360 settings).



Setup SD360 window

Note: If your system allows both SD360 and DR180+ recorders, and the Initialize DR180+ window opens, click the Initialize SD360 button to switch to the Setup SD360 window.

SD360 Patient setup window

Select the appropriate configuration corresponding to the patient to be hooked up (in the SD360 settings field at the right), then click Patient setup.

The Patient setup window allows you to enter clerical information about the patient to be saved on the SD card before the Holter test begins. See Chapter 2: Patient Information for details about data entry in this window.

Once the window contains the correct patient information, click the Copy to SD360 button. The card will be initialized and the patient data will be copied onto it.

For details about the settings available using the SD360 settings button, please refer to your SD360 Holter Recorder Operator's Manual.

Formatting a compact flashcard

To use a compact flashcard with NorthEast Monitoring's DR180+ and LX

Enhanced/Enhanced Plus software, it must be formatted properly before recording the patient data. Flashcards that come with the DR180+ Digital Holter Recorder are already formatted properly and need only to be erased before re-use. A flashcard from a different source, though, must first be formatted using the FAT file system (not FAT 32) and then erased using

NorthEast's software.

To format a compact flashcard, insert the card into your computer's card reader, then select My Computer. In the My Computer window, click on the icon designating your compact flashcard reader, then select File > Format. When the window opens, set the File system to FAT, then click Start. Click Close when formatting is complete.

Erasing/Initializing a compact flashcard

To erase and initialize a compact flashcard for re-use in the DR180+, insert the flashcard in your computer's flashcard reader and launch the Holter LX Pro software. Then select Patient > Flashcard > Initialize.

Note: If your system allows both SD360 and DR180+ recorders, and the Setup SD360 window opens, click the Initialize DR180+ button to switch to the Initialize DR180+ window instead.

In the Initialize DR180+ window, highlight the Standard selection and then click the Erase button. When the erase is completed, the flashcard will contain a blank flash.dat file that will allow it to be used in the DR180+.

Note: If you insert a flashcard into the recorder and get a message that the “Memory card is missing,” the flashcard is not formatted or erased properly.

NorthEast Monitoring Holter LX software is used in conjunction with data from the NorthEast Monitoring DR180+ and/or SD360 Digital Recorders. After a patient has worn the recorder, you take the compact flashcard or SD card from it and insert the card in your computer system’s compact card reader and the Holter signal is loaded onto your system. While the signal is being transferred, the LX software processes it, then you review the results, edit as needed, and print the report.

An overview of the process is covered in this chapter, and details are covered in subsequent chapters.

The Holter procedure

The Holter procedure typically includes the following steps:

- Holter the patient using a DR180+ or an SD360 Digital Recorder.
- Remove the recorder from the patient and remove the compact flashcard or the SD card from the recorder.
- Insert the card into the computer’s card reader.
- Start the Holter LX software.
- Enter information about the patient and the recording.
- Let the software analyze the Holter data.
- Using the Enhanced Plus software, review the templates in the Bin display to ensure that each type of beat is identified properly. Edit bins, templates, or beats as necessary. Make measurements as necessary.

Or:

- Using the Enhanced software, review the Critical Events found during the recording, correcting beats labels as necessary. Or use the Page window to review all the ECG recorded, relabeling single beats or all matches to beats, as appropriate.
- Review Critical Events or Page windows to save strips of additional significant events for the report.

- Review the Saved Strips, making sure that all significant events are documented and labeled properly.
- Type your comments about the Holter test in the Report Summary in the Report window.
- Print the final report to be reviewed by a physician.

Details about these steps appear in subsequent chapters in this manual.

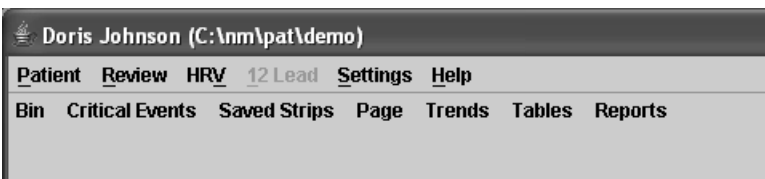
2 PATIENT INFORMATION

The Patient Information window contains important information about the patient who wore the DR180+ or SD360 recorder. The software automatically retrieves patient data from the recorder's memory card, along with the Holter signal, but you are responsible for entering the remaining data. The data saved by the DR180+ recorder includes an identification number, the recorder number, the date, the start time, and whenever the patient pressed the Event button. The SD360 saves all that information plus whatever clerical information was entered when the SD card was initialized for the recording. All entries in the Patient Information can be edited.

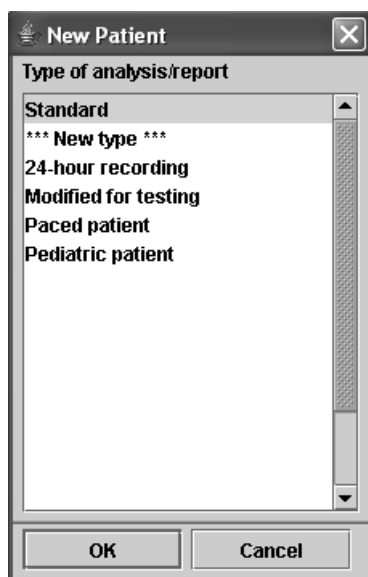
While running the Holter LX Enhanced/Enhanced Plus software, you have the choice of opening the Patient Information window for (1) the last patient whose Holter test was accessed (that is, the “current” patient), (2) a previous patient whose Holter test has already been analyzed, or (3) a new patient whose Holter test has not yet been analyzed. In the first two cases, a patient record has already been created for the patient and the Holter data for the patient has already been downloaded from the flashcard/SD card of the recorder onto the hard disk of your computer. In the case of a new patient, a new record must be created and the Holter information downloaded from the flashcard/SD card. This chapter covers creating a new patient record first.

Entering information for a new patient

To enter information about a new patient's Holter recording, the LX software must be running. When the program appears, it displays a blank screen with the standard toolbars. To start a new patient, first insert the patient's compact memory card into the card reader and then select Patient > New.



Standard Holter toolbars



Type of analysis/report window

After you select Patient > New, a Type of analysis/report window opens. Select Standard from the list and click OK.

Note: For more information about types of analysis/reports, see Chapter 10: Configurations.

Note: If you select Patient > New before inserting the card, you will see a Confirm window that explains that there is no flashcard in the drive. If this happens, insert the correct card into the drive and click Retry.

Note: If you see a message that says, “There are no empty patient...” instead of the window at left, see “Making room for new patients” in Chapter 9: Managing Patient Reports.

When the Patient Information window opens for a new patient, the data on the flashcard may be immediately read from the card reader; if it is not read automatically, click the Copy flashcard button in the Patient Information window. (Whether it is read automatically upon entering the window depends on a setting in the Preferences window; see Chapter 8: Preferences for more information.) As the Holter data from the flashcard loads onto your computer hard drive, you can start entering patient information.

Note: Once the flash.dat has loaded, the Copy flashcard button in the Patient Information window changes to “Copy different flashcard.” If the patient information displayed does not match the correct patient, remove the flashcard, insert the correct one and click “Copy different flashcard.”

New Patient Information window

1. Type the patient name using the Last name, First name, and Middle initial (MI) fields appropriately. Use your pointing device (mouse) to click on the next field you want to fill in, or press the Tab key to move to the next field. The name in the printed report appears as entered in this window.

2. Fill in any of the remaining data fields. There are six types of data fields:

- **Freeform:** These allow you to type alphanumeric characters, limited by the space constraints displayed, e.g., patient name.
- **Radio buttons:** The Sex entry appears as this type. Circles represent the two choices. Click on a circle to select it. Only one choice can be selected.



Example of radio button

- **Formatted:** The entry must be in a specific format. For example, the D.O.B. (date of birth) field must be entered as one of the valid formats; which one depends on the settings of your system. If the D.O.B. field reads MM/DD/YYYY, the entry must be typed with the first two digits representing the month, the second two digits representing the day, and the final four digits representing the year. If the D.O.B. field reads DD-MON-YYYY, the entry must be typed with two digits representing the day, three letters representing the abbreviation for the month, and four digits representing the year. (To change the D.O.B. format, see Chapter 8: Preferences.)
- **Automatic:** These are filled in automatically from the flashcard.
- **Check box:** The fields with an empty square can be clicked on to

display a check mark. Click again to remove the mark.

- **Combination:** In these, you can either type a freeform entry or make a selection from a predetermined list of choices. To display the list of choices, click on the scroll arrow to the right of the field. In the Indication and Medication fields, the scroll arrow does not appear until you click on the field itself. To select a choice from the list, click on it.

Some combination boxes have an auto-fill feature. When you start typing an entry, the software will automatically finish typing for you from its list of choices; if the word taken from its list is incorrect, simply keep typing until the correct one appears. If the correct one is not on the list, type the complete entry. These fields have the auto-fill feature: Indication, Medication, Physician, Interpreting physician, and Strip label.

Note: *The D.O.B. and Age fields work together. If you know the patient's date of birth, enter it, and the software automatically calculates the patient's age based on the D.O.B. and the recording date. If you do not know the date of birth, but know the age, type a numeric entry in the Age field, and select the appropriate unit (e.g., years) in the Age Unit field. If you know neither, leave the fields blank. The software does not allow an inconsistent D.O.B. and age; if you enter inconsistent data, it will leave the age and remove the D.O.B.*

Note: The Notes field allows an alphanumeric entry that can be used to record information that might be helpful about the Holter test or the patient. It is not printed in the final report. To enter notes to be printed in the final report, use the Comments section of the Report summary.

Entering diary information

While wearing the DR 180+ or SD360, the patient can identify symptoms and activities in two ways:

- (1) by pressing the Event button on the recorder and, possibly, entering a pre-coded symptom or activity (DR180+ only), or
- (2) by keeping a written record of times and symptoms or activities.

The software reads the Event button information directly from the flash-card/SD card and enters it automatically. You must type any significant information from the written record manually into the Diary Symptoms window.

	Time	Symptom
1	10:45:00am-1	Palpitations
2	12:10:00pm-1	Dizzy
3	03:30:00pm-1	Palpitations while walking
4	HH:MM:00am-1	
5	HH:MM:00am-1	
6	HH:MM:00am-1	
7	HH:MM:00am-1	
8	HH:MM:00am-1	
9	HH:MM:00am-1	
10	HH:MM:00am-1	

Delete Done

Diary Symptoms window

To open the Diary Symptoms window, click the Diary button in the Patient Information window. The Diary Symptoms window contains two types of fields: time and symptom. Any entries that are already present when you first open a patient's Diary Symptoms window were those automatically read from the memory card.

Enter the time-of-day and symptom for each diary event recorded.

Note: Whether the software uses a 12- or 24-hour clock is determined by your computer's setting in the Control Panel.

Time-of-day

To enter the time-of-day of a written symptom or activity, click on the text in the time field. Type over the existing characters, using the format indicated, with either a 12- or 24-hour clock:

- HH stands for a two-digit hour.
- MM stands for a two-digit minute.
- 00 stands for a two-digit second; this is automatically filled in with 00 so that you do not have to type the seconds.
- using a 12-hour clock format, am stands for the morning and pm stands for the afternoon; change the "a" to "p" if necessary.
- 1, 2 or 3 at the end indicates Day 1, Day 2, or Day 3.

Symptom

To enter a symptom, first click on the Symptom field next to the appropriate time-of-day. Then enter the text either by typing a freeform entry or by clicking on the arrow to display a scrolling list of pre-typed entries. To enter a selection from the list, click on it; the list window closes and the entry appears in the Symptom field. You can also add freeform information after selecting a pre-typed entry. To do so, make your selection, then click at the end of the text and type the additional information, followed by the Enter key.

To delete a diary entry, click in the time-of-day field of the entry and then click the Delete button. The time-of-day will revert to HH:MM:00-1 or HH:MM:00am1 and no entry will be saved. To select multiple entries to be deleted, select one and then hold the Shift key down while you select subsequent entries; when all entries that you want deleted are highlighted, click Delete.

When you have finished entering all written diary events, click the Done button to save your entries and return to the Patient Information window.

Changing Settings

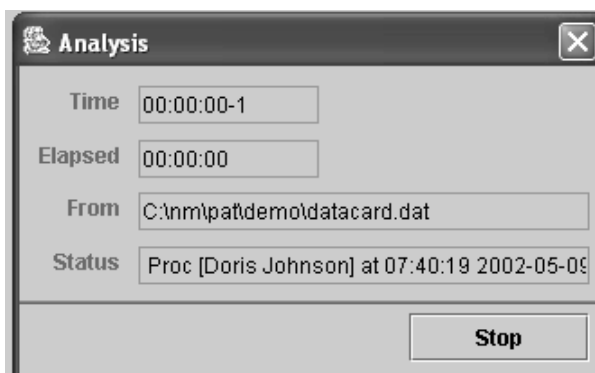
During Holter analysis, the LX Enhanced/Enhanced Plus software makes decisions about the Holter signal based on a variety of pre-defined settings. You can change any of the analysis criteria in the Settings win-

dows, which are accessible from the menu displayed by clicking the Settings button in the Patient Information window or by clicking the Settings menu item in the main toolbar.

Adjustments that can be made in the Settings windows are detailed in “Changing Settings” section of Chapter 3: Holter Analysis.

Starting Holter analysis

To start Holter analysis after entering patient data, click the Start button at the bottom of the Patient Information window. The Analysis window appears. When analysis is complete, the Analysis window closes automatically.



Analysis window

To interrupt analysis, click the Stop button. The analysis ends immediately, with data only for the portion that was complete. The unanalyzed ECG can be reviewed in Page and printed in full disclosure.

Details of the analysis process are presented in Chapter 3: Holter Analysis.

Editing patient information for the “current” patient

After analysis is completed for a patient’s Holter data, you can re-open the Patient Information window and edit the information in it. To open the Patient Information window for the current patient, select Patient > Patient Information.

Patient Information window for analyzed (not new) patient

While most of the Patient Information window is the same as that of a new patient, there are significant differences:

- The addition of the Status button (see the “Status window” section below for details).
- The Re-analyze button replaces the Start button because the Holter signal has already been analyzed. (See Chapter 3: Holter Analysis for information about using the Re-analyze button.)

- The absence of the Copy different flashcard button. To copy the Holter data from a flashcard/SD card, you must use Patient > New.

Status window

After a patient’s Holter signal has been analyzed, the Patient Information window also includes a Status button that opens the Status window. The Status

window helps you keep track of the status of each patient’s Holter test. As you complete each step, you can click on the check box next to each field in the Status window to indicate that the step has been completed. The Status fields include:

- **Edited** indicates that the Holter signal was reviewed and edited as needed;
- **Printed** means the report was printed;
- **Verified** means the report was reviewed and approved by a qualified physician;
- **Locked** removes all editing capabilities from the Patient Information and Review

Status window

windows. No changes are allowed.

In addition, one other Status field appears - Backup. That field is filled in automatically when you use the Backup program to save a patient's Holter information; it contains either "Full" to indicate that all Holter data is backed up with the patient report or "Report" to indicate that just the compiled report is backed up for this patient.

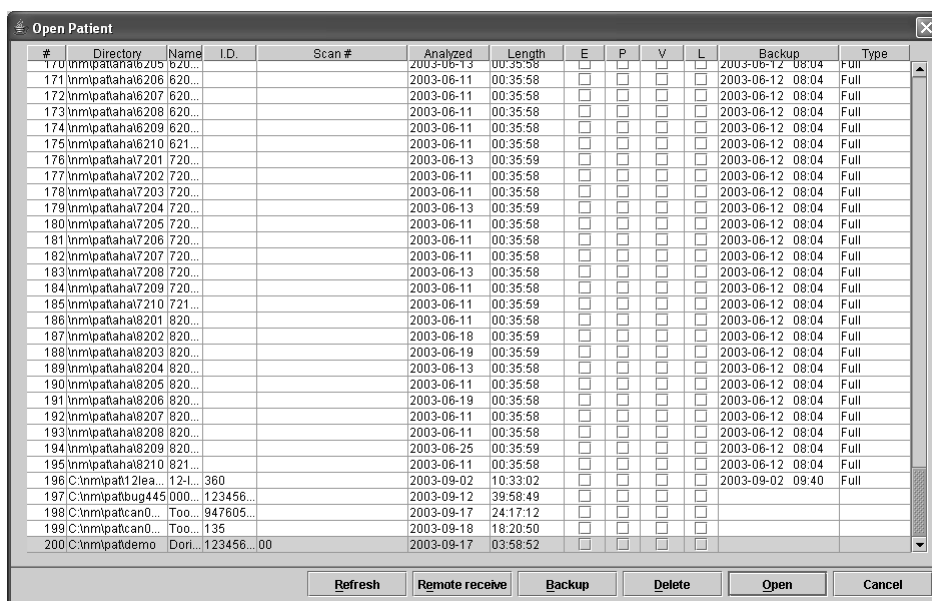
Navigating the patient list

You can keep multiple patient Holter recordings and reports on your computer system. All of the patients currently saved in the software appear when you select Patient > Open from the toolbar.

The list of patients in the Open Patient window includes information regarding each report. Although the particular fields are customizable in the Backup program, the fields included in the standard release of the LX Enhanced/Enhanced Plus

software are: the name of the directory in which the patient's report is stored, the patient name, the I.D. number, the Scan #, and the analysis date. The Backup field displays the date that the report was backed up on your system; Type indicates what is backed up - either the report, including strips (indicated by "Report"), or the full report (indicated by "Full"), consisting of the report plus the entire Holter recording.

At any one time, only one patient is the current patient - the patient whose information appears when you select Patient > Patient Information, the patient whose ECG appears in the screen displays, the patient whose report prints when you make the request. To change the current patient to a different one, either click on the appropriate name on the list and click Open, or double-click on the appropriate line.



#	Directory	Name	I.D.	Scan #	Analyzed	Length	E	P	V	L	Backup	Type
170	nmmpatahah6205	620...			2003-06-13	00:35:58					2003-06-12 08:04	Full
171	nmmpatahah6206	620...			2003-06-11	00:35:58					2003-06-12 08:04	Full
172	nmmpatahah6207	620...			2003-06-11	00:35:58					2003-06-12 08:04	Full
173	nmmpatahah6208	620...			2003-06-11	00:35:58					2003-06-12 08:04	Full
174	nmmpatahah6209	620...			2003-06-11	00:35:58					2003-06-12 08:04	Full
175	nmmpatahah6210	621...			2003-06-11	00:35:58					2003-06-12 08:04	Full
176	nmmpatahah7201	720...			2003-06-13	00:35:59					2003-06-12 08:04	Full
177	nmmpatahah7202	720...			2003-06-11	00:35:58					2003-06-12 08:04	Full
178	nmmpatahah7203	720...			2003-06-11	00:35:58					2003-06-12 08:04	Full
179	nmmpatahah7204	720...			2003-06-13	00:35:59					2003-06-12 08:04	Full
180	nmmpatahah7205	720...			2003-06-11	00:35:58					2003-06-12 08:04	Full
181	nmmpatahah7206	720...			2003-06-11	00:35:58					2003-06-12 08:04	Full
182	nmmpatahah7207	720...			2003-06-11	00:35:58					2003-06-12 08:04	Full
183	nmmpatahah7208	720...			2003-06-13	00:35:58					2003-06-12 08:04	Full
184	nmmpatahah7209	720...			2003-06-11	00:35:58					2003-06-12 08:04	Full
185	nmmpatahah7210	721...			2003-06-11	00:35:59					2003-06-12 08:04	Full
186	nmmpatahah8201	820...			2003-06-11	00:35:58					2003-06-12 08:04	Full
187	nmmpatahah8202	820...			2003-06-18	00:35:59					2003-06-12 08:04	Full
188	nmmpatahah8203	820...			2003-06-19	00:35:59					2003-06-12 08:04	Full
189	nmmpatahah8204	820...			2003-06-13	00:35:58					2003-06-12 08:04	Full
190	nmmpatahah8205	820...			2003-06-11	00:35:58					2003-06-12 08:04	Full
191	nmmpatahah8206	820...			2003-06-19	00:35:58					2003-06-12 08:04	Full
192	nmmpatahah8207	820...			2003-06-11	00:35:58					2003-06-12 08:04	Full
193	nmmpatahah8208	820...			2003-06-11	00:35:58					2003-06-12 08:04	Full
194	nmmpatahah8209	820...			2003-06-25	00:35:59					2003-06-12 08:04	Full
195	nmmpatahah8210	821...			2003-06-11	00:35:58					2003-06-12 08:04	Full
196	C:\nmppat12lea...	12-L...	360		2003-09-02	10:33:02					2003-09-02 09:40	Full
197	C:\nmppatbug445	000...	123456...		2003-09-12	39:58:49						
198	C:\nmppatcano...	Too...	947605...		2003-09-17	24:17:12						
199	C:\nmppatcano...	Too...	135		2003-09-18	18:20:50						
200	C:\nmppatdemo	Dori...	123456...00		2003-09-17	03:58:52						

An example of the Open Patient window

Also, you can change the current patient using the << and >> buttons in the bottom of the Holter LX window. << changes the current patient to the previous one on the patient list. >> changes the current patient to the next one on the patient list. Click each button repeatedly to move backward or forward through the list. To display a combo box listing all patients on the system, click the arrow to the left of the << and >> buttons.

For more information about managing and backing up the patient records saved on the system, see Chapter 9: Managing Patient Reports.

Previewing the data on the compact flashcard/SD card

If you would like to review the clerical information on a flashcard/SD card before creating a new patient record, you can insert the card into the drive and then select Patient > Preview from the main toolbar. This opens the Preview window, which displays the identification and recorder numbers, along with the date recorded and the start

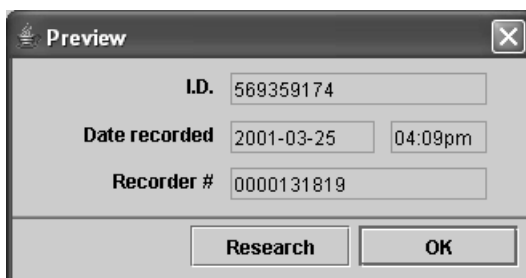
time, directly off the card without loading the information onto your computer's hard disk. Use this feature to verify which flashcard contains a particular patient's Holter data.

After verifying that the card is the correct one, click OK to close the window. If the information in the Preview window does not match the information you have, do not proceed without clearing up the discrepancy.

After verifying that the card is from the correct patient, select Patient > New and follow the normal procedure described at the beginning of this chapter.

Closing the Patient Information window

To save your data and close the Patient Information window without starting analysis, click OK. To close it without saving any changes, click Cancel.



Preview window

3 HOLTER ANALYSIS

During analysis, the Holter LX Enhanced/Enhanced Plus software detects each R-wave; determines the patient's normal morphology; establishes normal, ventricular and paced templates; matches every beat to a template; counts normal, supraventricular, ventricular and paced beats, including any pairs and runs; measures RR intervals and calculates heart rates; does ST segment analysis; counts other abnormalities as defined in the Scanning Criteria; and saves sample strips for the final report. You can review and edit decisions made by the software; the information is then either re-analyzed or updated to include your changes. This chapter addresses the features that you have control over during analysis, re-analysis and updating.

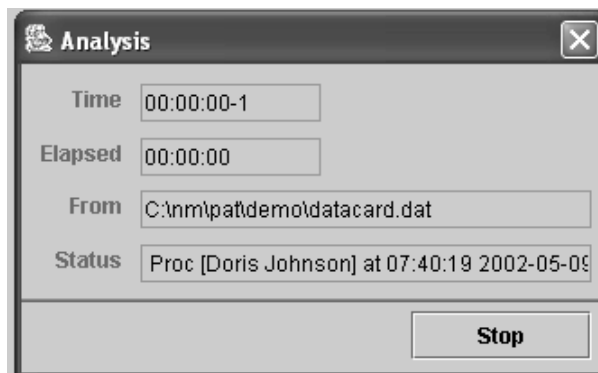
Starting Holter analysis

To start Holter analysis for a new patient, you must have the correct patient's compact flashcard/SD card in the card reader before selecting Patient > New. After you have entered the patient information (see Chapter 2: Patient Information, for details about data entry), click the green

Start button at the bottom of the Patient Information window to start analysis.

The Analysis window appears. When analysis is complete, the Analysis window closes automatically.

To interrupt analysis, click the Stop button. The analysis ends immediately, with data only for the portion that was analyzed by the time of the interruption. The unanalyzed ECG can be reviewed in Page and printed in full disclosure.



Analysis window

Arrhythmia analysis

Certain analysis and related documentation criteria are already set when you click the Start button in the Patient Information window. They include all the settings that appear in the five windows that are accessible using the Settings button in either the Patient Information window or on the main Holter toolbar. Those windows are What Strips to Auto Save, How Often Strips Auto Save, Scanning Criteria and Oximetry.

What Strips to Auto Save

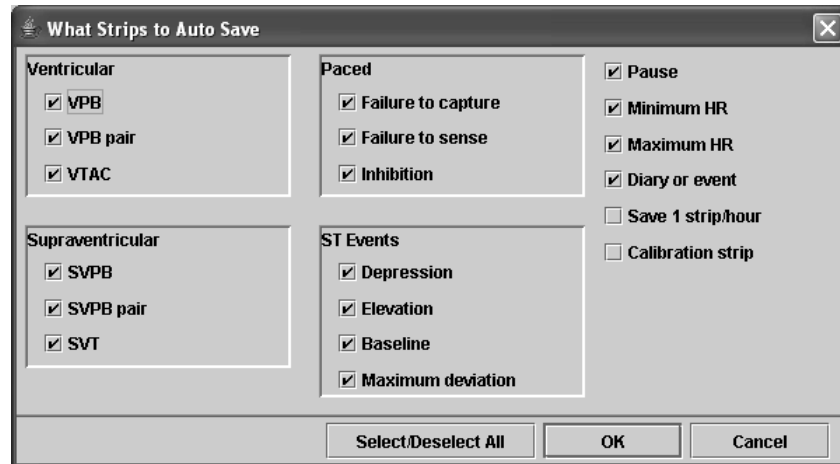
All the different types of labels the software uses appear in this window. Each label can be turned off or on to indicate whether sample strips of that type should be saved for the final report. A check mark indicates that sample strips with that label will be saved.

Click on a label or its check box to turn it off or on. Click on the button Select/Deselect All to turn all labels on or off. Click OK to save changes and close the window, and click Cancel to close the window without saving changes.

The labels in the What Strips to Auto Save window are defined as:

- **VPB** - a beat that matches a ventricular template, regardless of prematurity
- **VPB pair** - two VPBs in a row
- **VTAC** - three or more VPBs in a row, regardless of heart rate
- **SVPB** - a beat that matches a normal template, but occurs at least as early as the SVPB prematurity setting in the Scanning Criteria window
- **SVPB pair** - two SVPBs in a row
- **SVT** - three or more SVPBs in a row, regardless of heart rate
- **Failure to capture** - the presence of a pacemaker spike without a following R-wave
- **Failure to sense** - the occurrence of a paced beat too soon following another beat; that is, too short an RR interval
- **Inhibition** - the absence of a paced beat when it should occur; that is, too long an RR interval
- **Depression** - at least a 1 millimeter depression in the ST segment compared to the patient's normal
- **Elevation** - at least a 1 millimeter elevation in the ST segment compared to the patient's normal

Note: Please refer to the section "Pacemaker analysis" in this chapter for more information about the pacemaker labels.



What Strips to Auto Save window in Settings menu

Note: The Depression and Elevation settings here are NOT strip labels. Instead, they determine whether strips of the following types are saved for each episode of ST Depression or Elevation detected by the software.

- **Baseline** - a sample of the patient's normal ST segment preceding a detected event
- **Maximum deviation** - the ECG at the point of maximum change from the normal

Note: Please refer to the section "ST Segment Analysis" in this chapter for more information about the ST labels listed above.

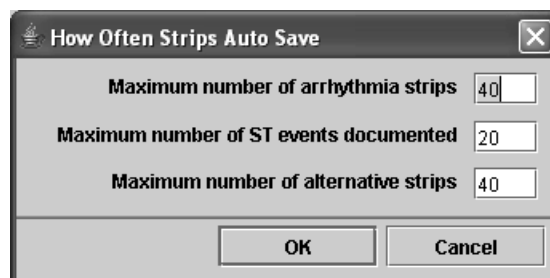
- **Pause** - an RR interval at least as long as the Pause length in the Scanning Criteria window
- **Minimum HR** - the minimum heart rate calculated using the heart rate algorithm described in Appendix A, generally a four-beat running average
- **Maximum HR** - the maximum heart rate calculated using the heart rate algorithm described in Appendix A, generally a four-beat running average
- **Diary or event** - a strip at the time-of-day when either (1) the event button was pushed or (2) an entry was manually typed into the Diary window
- **Save 1 strip/hour** - a strip at the onset of each new hour
- **Calibration strip** - the calibration signal at the onset of the Holter recording

How Often Strips Auto Save

These settings control the distribution of strips that are saved for the report. They have the following uses:

- **Maximum number of arrhythmia strips:** Selected Strips fall into two types - arrhythmia and ST. You can limit how many arrhythmia strips are saved for the final report by adjusting this field.
- **Maximum number of ST events documented:** Each ST event, regardless of whether it is depression or elevation, can have two strips saved to document it. To reduce the number of events for which strips are saved, enter a smaller number in this field. To change which strips are saved per ST event, make the change in the What Strips to Auto Save window.
- **Maximum number of alternative strips:** Two strip labels are associated with alternative strips in the Saved Strips window - Minimum HR and Maximum HR. Here you control how many alternative selections you have for those labels.

To make changes, select the current entry and type over it. Click on OK to save changes and exit; click Cancel to close without saving.



How Often Strips Auto Save window in Settings menu

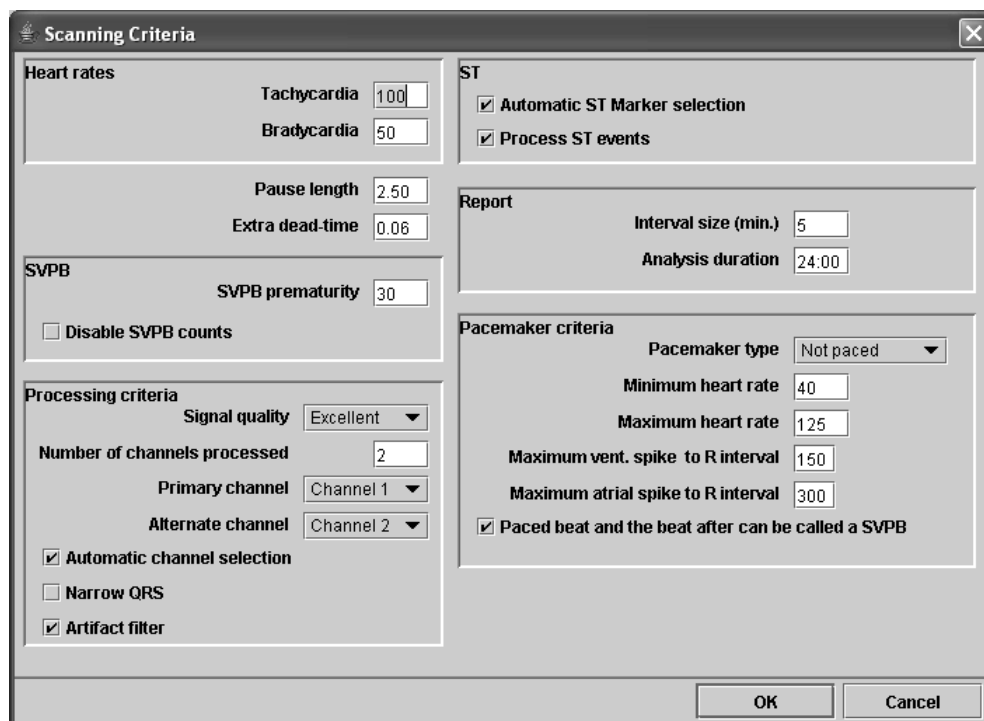
Scanning Criteria

The Scanning Criteria are used during Holter analysis to define some of the arrhythmias labeled by the software, along with settings that control the amount of information processed. The Scanning Criteria window is shown on the following page. The adjustable criteria include:

- **Tachycardia** defines at least how fast a heart rate must be for the Tachycardia label to appear. This is a label that appears in Expanded Page.
- **Bradycardia** defines how low the heart rate must be for the Bradycardia label to appear. This is a label that appears in Expanded page.
- **Pause length (sec.)** defines how long an RR interval must be for the beat at its onset to be called a Pause and appear white on the colored display. This RR interval can be initiated by any type of beat except artifact.
- **Extra dead-time** controls the tail end of the dead-time period following an R-wave during which another QRS complex cannot be detected, allowing for the presence of a T-wave. Increase the time (in seconds) if large T-waves are being identified as R-waves, and decrease the time if early beats are being missed. See details in Appendix A.
- **SVPB prematurity** (percent) sets the requirement for how early a beat that matches a normal (or aberrant) template must be for it to be identified as an SVPB. For example, at a heart rate of 60 beats per minute, a normal RR interval is 1 second long, and a beat that is 10 percent premature would fall at 0.9 seconds after the preceding beat. A properly timed beat would be 0 percent premature; that is, not early.
- **Disable SVPB counts** is a setting that allows you to turn off the identification and counting of SVPBs. Use it when the patient exhibits atrial fibrillation or any other time the SVPB count is not appropriate.
- **Signal quality** has three settings that control the amount of artifact that is tolerated before the signal is thrown out because of too much artifact:
 1. **Research** turns off the artifact detector so that none of the signal except the first minute and the last minute of the recording is called artifact. This results in the analysis of all the signal, including any artifact.
 2. **Excellent** allows the software to detect and reject a moderate amount of artifact. Any signal that is determined to be contaminated with artifact appears light blue and is not analyzed. Anything that occurs during periods of artifact is not counted.
 3. **Normal** allows the software to discard any signal that it considers contaminated by artifact. Anything that occurs during periods of artifact is not counted.
- **Number of channels processed** determines whether the software uses one or two channels to determine the location of an R-wave and what template each matches. Single-channel analysis uses just the channel set in the Primary channel field. Dual-channel analysis uses the Pri-

primary channel to locate R-waves first, then refers to the Alternate channel as a back-up channel to locate R-waves, and both primary and alternate to do template-matching.

- **Primary channel** determines which channel is used during analysis. For single-channel analysis, the primary one is the only one used to locate R-waves and do template-matching. For dual-channel analysis, the primary channel is used first to locate R-waves, but if an R-wave cannot be located, the software refers to the alternate channel to locate the beat, if one is present.
- **Alternate channel** is used only in two-channel processing. It determines which channel is used in case an R-wave is not found in the primary channel, and it controls which channel is used as a second channel for template-matching.
- **Automatic channel selection** allows the software to switch primary and alternate channels if it determines that signal has been lost in the primary channel. Turn this off to force the software to use a particular primary or alternate channel. If you change the Number of channels processed field to 1, this setting is turned off automatically.
- **Narrow QRS** permits the software to identify narrower-than-normal QRS complexes, like those seen in pediatric patients, as normal beats. Turn this on routinely for pediatric patients.
- **Artifact filter** works in conjunction with the Signal quality setting. If it is turned on and Signal quality is set to Normal, the filter limits the response to 20 Hz, instead of 70. If



The Scanning Criteria window is a dialog box with a title bar and a close button. It contains several sections of settings:

- Heart rates:** Tachycardia (100), Bradycardia (50).
- Pause length:** 2.50.
- Extra dead-time:** 0.06.
- SVPB:** SVPB prematurity (30), ☐ Disable SVPB counts.
- Processing criteria:** Signal quality (Excellent), Number of channels processed (2), Primary channel (Channel 1), Alternate channel (Channel 2), ☒ Automatic channel selection, ☐ Narrow QRS, ☒ Artifact filter.
- ST:** ☒ Automatic ST Marker selection, ☒ Process ST events.
- Report:** Interval size (min.) (5), Analysis duration (24:00).
- Pacemaker criteria:** Pacemaker type (Not paced), Minimum heart rate (40), Maximum heart rate (125), Maximum vent. spike to R interval (150), Maximum atrial spike to R interval (300), ☒ Paced beat and the beat after can be called a SVPB.

At the bottom right are OK and Cancel buttons.

Scanning Criteria window in Settings menu

it is on and the Signal quality is set to Excellent or Research, the filter limits the response to 30 Hz instead of 70.

- **Automatic ST Marker selection** allows the software to detect the j-point and set up the ST markers appropriately. If you manually change the ST marker locations in the Calibration window, this setting will turn off automatically.
- **Process ST events** lets you turn ST segment analysis on or off, depending on your preference.
- **Interval size (min.)** determines how many minutes are including in each interval in the interval tables of the Tables window.
- **Analysis duration** determines how many hours of data are analyzed. All the ECG loads in from the compact during analysis, but analysis stops after the amount of time indicated here or at the end of the Holter recording, whichever comes first. It uses the HH:MM format, with the first two digits indicating how many hours and the second two indicating how many minutes.
- **Pacemaker type** contains four settings that allow the software to expect certain behavior:
 1. **Not paced** means that the software will not identify any pacemaker spikes, beats or failures.
 2. **VVI** means that each paced beat will be preceded by a single spike. All paced beats are counted as ventricular paced.
 3. **AV sequential** means that paced beats will be preceded by two pacemaker spikes, one atrial and one ventricular. All paced beats are counted as AV paced.
 4. **DDD** means that paced beats can be preceded by either one or two pacemaker spikes. Depending on the spike's location relative to the following R-wave, a beat preceded by a single spike can be called either atrial paced or ventricular paced, while a beat preceded by two spikes can be counted as AV paced.
- **Minimum heart rate** refers to the minimum rate allowed by the pacemaker. If the pacemaker does not fire appropriately and there is an RR interval longer than the patient should experience, the Inhibition label appears; examples appear in Critical Events (under Inhibition in Enhanced Plus, and under Paced Failure in Enhanced edition).
- **Maximum heart rate** refers to the maximum rate initiated by the pacemaker. If the pacemaker fires early, which would result in a faster rate, the Sense failure label appears; examples appear in Critical Events (under Sense Failure in Enhanced Plus, and under Paced Failure in Enhanced edition).
- **Maximum vent. spike to R interval** sets the maximum time between the firing of the second pacemaker spike and the following R-wave. If the second spike appears and is not followed by an R-wave in this amount of time, the Capture failure label appears; examples appear in Critical Events (under Capture Failure in Enhanced Plus, and under Paced Failure in Enhanced edition).
- **Maximum atrial spike to R interval** sets the limit for how long is

allowed between a single spike and the subsequent R-wave. If a single spike occurs and the following R-wave is not within this amount of time, the Capture failure label appears; examples appear in Critical Events (under Capture Failure in Enhanced Plus, and under Paced Failure in Enhanced edition).

- **Paced beat and the beat after can be called a SVPB** is a setting that allows you to identify early beats following a paced beat as SVPBs because they were premature.

Note: Please refer to the section “Pacemaker analysis” in this chapter for more information about the pacemaker settings listed above.

Re-analysis

If you have already analyzed the patient’s Holter test, changes that you make to some of the settings may force the software to re-analyze the patient’s data, while others require an update to take effect.

Because changes in some of the settings have such a fundamental effect on the data, the analysis step is repeated using the new settings. That step is called re-analysis. Re-analysis is required after changing any of the settings in the Processing criteria and Pacemaker criteria areas of the Scanning Criteria window, along with changes to either of the two Processing modes, the Analysis duration, and the

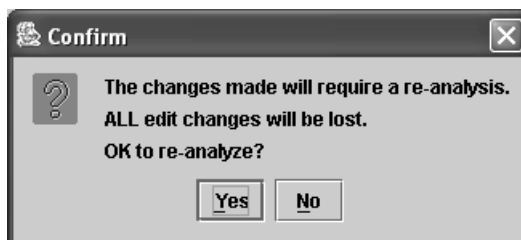
Extra dead-time. After making a change to any of these settings and clicking on OK to close the window, the software asks you to confirm that you want the data re-analyzed or not. If you want the change to take effect, click Yes. If not, click No.

Although re-analysis itself takes a brief amount of time (the same as analysis), the patient will be newly analyzed again and all editing changes you have made previously will be gone.

Note: Because re-analysis is required after a change in some Settings, be sure to make any changes to the Settings before you work on the final report. Any bin (in Enhanced Plus edition only), template or beat editing, along with manually saved sample strips and typed comments will be lost after some changes in the Settings.

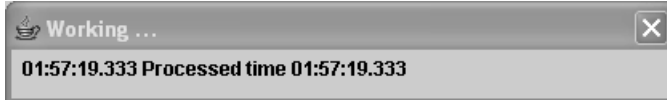
Update

Some changes in the Settings require an update afterward, just as beat, template and bin editing (in Enhanced Plus) and single-beat and all-matches editing in Page require an update afterward. The update incorporates simple changes into all other aspects of the report. For example, a change in all



Confirm window asking whether to re-analyze

matches to a beat with 12 matches from ventricular to aberrant will affect other aspects of the report: the total count of VPBs will decrease by 12 and SVPBs will increase by 12 in Tables, Critical Events, Trends, and Report Summary. In addition, different Saved Strips will be selected.



Update window

Those changes in Settings that require an update are all those in the What Strips to Auto Save and How Often Strips Auto Save windows, along with these settings in the Scanning Criteria window - Tachycardia and Bradycardia rates; Pause length; Disable SVPB counts; Interval size; and SVPB prematurity.

Note: Because update is required after a change in some Settings, be sure to make any changes to the Settings before you edit Saved Strips, Tables and Report Summary for the final report. Bin, template or beat editing done before the update will not be lost.

If an Update button does not appear in the Review toolbar, it means the Automatically Update feature is turned on in the Preferences window. When you make a Settings change that requires an

update, the update will occur automatically when you close the window.

If an Update button appears in your Review toolbar, the Automatically Update feature is turned off in the Preferences window. That means that after some editing changes, you must click the Update button to incorporate your changes. After you make changes that require an update, the Update button will blink red as a reminder that you must at some point click it.

Note: Whether the Update button appears in the Review toolbar depends on the “Automatically update tables” setting in the Preferences window. If the software is set to automatically update, the button does not appear; if you must update the data after making changes, the button appears.

Oximetry analysis

If you have oximetry hook-up equipment for your DR180+ Digital Recorder, oximetry analysis is done automatically when you start Holter analysis, using the patient's data from the compact flashcard. The oximetry option is not available using the SD360 recorder.

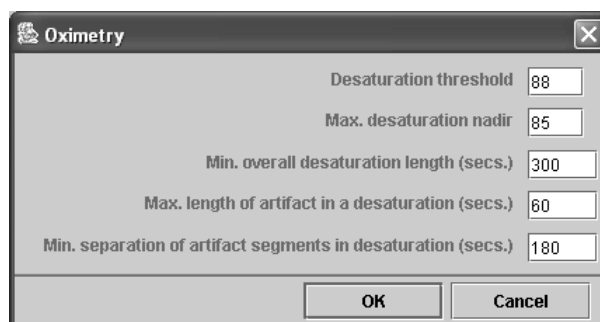
The oximetry data appears in the channel 3 area of all ECG displays. This includes a color-coded (based on the beat label, so usually green) trend of the SpO2 data, with a vertical scale of 60 to 100 percent saturation; artifact in that trend is indicated by vertical hash marks. Pulse oximetry data is displayed as the white trend above the SpO2 trend.

In addition, the ST trend in the Trends window shows the oximetry data in two areas - the heart rate data collected appears superimposed on the heart rate trend and the oximetry readings are plotted instead of the channel 3 ST data. Desaturation events are highlighted in red along the oximetry trend.

Desaturation events are defined by the settings in the Oximetry window in the Settings menu.

The adjustments you can make include:

- **Desaturation threshold** (percent) defines the oxygen level (SpO2 value) that every reading during a desaturation event must be below. The duration of an event is defined as a time period during which no reading was above this level.
- **Max. desaturation nadir** defines the SpO2 level that must be met for an event to be identified as a desaturation event. During the event, at least one reading must drop to this level.
- **Min. overall desaturation length (in seconds)** determines how long the readings must remain at or below the Desaturation threshold to be considered a desaturation event.
- **Max. length of artifact in a desaturation (in seconds)** defines the maximum amount of sequential artifact that can occur during a desaturation event and still have it reported as an event.
- **Min. separation of artifact segments in desaturation (in seconds)** defines how close periods of artifact can be within a desaturation event and still have it reported as an event.



Oximetry window in Settings

ST segment analysis

ST segment analysis includes these steps (which are each explained in depth in the following pages):

1. **Setting ST markers.** This is done automatically by the software, but you can adjust the markers for any patient.
2. **Measuring the ST segment** on all three channels of every normal beat. This is done automatically. If you relabel normal beats to some other label, the ST segment analysis will be re-done automatically.
3. **Plotting ST data** in 30-second increments. All normal beats within each 30-second time period are averaged.
4. **Establishing ST baseline** for the patient throughout the Holter period. The software does this automatically and plots it in blue on the ST trends in the Trends window.
5. **Comparing the 30-second ST segment data** measured with the baseline at the same time. A difference of at least 1 millimeter in any channel is considered to be an event. Again, the software does this automatically.
6. **Identifying ST events.** ST events are listed in the ST event table in the Tables window. This is automatically compiled for you, but you can edit any of the fields within the table.
7. **Documenting ST events.** You determine which strips are saved to document each event, based on the settings in the What Strips to Auto Save window. How many ST events

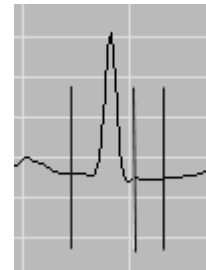
are documented is determined in the How Often to Auto Save window.

Note: *The procedure does not include calibrating the signal because the data is recorded at 1 centimeter per millivolt, the standard for ST segment analysis.*

Setting ST markers

To review the locations of the ST markers used during analysis:

1. Select Review > Calibration. The Calibration window opens displaying the calibration pulse, a series of eight 1-millivolt square waves.
2. Click the radio button to the left of “ST Marker” to change the display to ECG and three colored, vertical markers, which include:
 - the left-hand marker (cobalt blue) indicates where iso-electric is in the baseline preceding the QRS complex;
 - the middle marker (yellow) is located at or just following the j-point (where the QRS ends and the ST segment begins); and
 - the right-hand marker (light blue) is located during the ST segment.



The three ST markers

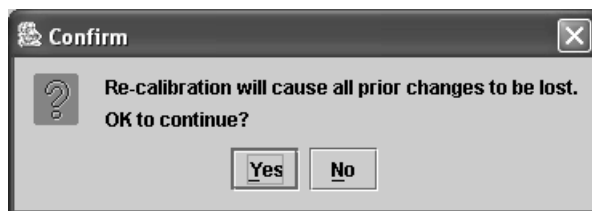
Note: *If the ECG displayed is not clean and representative of the patient's normal, click the down arrow of the scroll bar to jump forward to different ECG*

3. If the markers are not located where you want them, drag them to the

appropriate locations. The ST segment measurement can be made at the location of either the j-point or the ST segment marker, while the other of the two is used to indicate the slope of the ST segment. The time between those two markers is listed in the field labeled “ST Segment (ms).” Be sure to locate each marker based on your facility’s protocol.

Note: *Each marker for each channel moves independently so that you can precisely position the markers based on each channel’s morphology.*

4. Once each marker is in the appropriate location, click the radio button next to Done. If you have made changes to either the Gain or the ST Marker window, a window opens asking whether it’s okay to continue. Click on Yes to make the change and continue. Click No to cancel your changes and retain the previous information.



Confirm window

5. To exit from the ST Marker window without saving your changes, click the radio button next to Cancel.

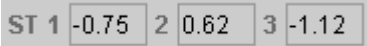
Measuring the ST segment

This is performed automatically for all three channels of ECG. Whether the ST segment measurement is done at the

position of the j-point or the ST segment marker is determined by the setting “ST measurement” in the Preferences window. See Chapter 8 for details of the Preferences settings and their use.

The ST segment measurement is averaged in 30-second increments throughout the Holter period. Only normals not contaminated by artifact are included in each average. At least eight valid measurements must be made within a 30-second period for it to be included; if there are fewer than eight clean normal beats, the 30-second increment is considered artifact.

For any particular beat, you can measure the ST segment manually by going to the Page display and selecting the beat as the current beat. In the Expanded

display, drag  the left *ST 1, 2 and 3 fields* marker to define iso-electric and the right marker to the appropriate location of the ST segment. The vertical difference between where the two markers intersect each channel of ECG is listed in the ST 1, 2 and 3 fields in the Expanded toolbar.

Plotting ST segment data

The data for all three channels is plotted in the ST level display of the Trends window. To display it, select Trends from the Review toolbar and then select ST level in the Type field.

The top trend is minute-by-minute heart rate. Immediately below that is the ST trend for channel 1, then channel 2, with channel 3 on the bottom.

Each trend shows the patient's calculated baseline as a cobalt blue trend, with the patient's ST measurement plotted in green and the slope of the ST segment indicated by a red vertical line.

The software calculates the patient's ST baseline from the patient's normal ST segment measurements as the Holtered period progresses. ST segment changes that are caused by positional changes result in changes in the patient's baseline, and are not usually considered ST events themselves. The patient's baseline during what ends up being an ST event is interpolated from the baseline before and after the event.

The significance of establishing a patient's baseline is that it means that normal is not always defined as iso-electric (that is, with no voltage) and that significant changes are relative to the patient's baseline, not to iso-electric.

Identifying ST events

The ST analysis software looks through the ST level trends, comparing the ST trends to the patient's baseline trends, to find episodes of significant ST segment changes.

For an incident to be called an ST event, at least one 30-second ST segment data point must be at least 1 millimeter different than the patient's baseline for that channel at that time-of-day. A depression is a change of at least 1 millimeter in the negative direction, while an elevation is a change of at least 1 millimeter in the positive direction.

In the ST level trends, incidents that are flagged as ST segment events are indicated by a light blue horizontal line above the appropriate channel and lasting as long as the event.

The events are listed in the ST event table in the Tables window. To display it, click Tables in the Review toolbar, then click on ST event in the Tables list at the right of the Tables window. In that table, the description for each event includes:

- **Channel** - the channel in which the event was detected
- **Onset** - the time-of-day at the start of the event (defined as when the change in ST segment passes through the point 0.5-millimeter different from the patient's baseline)
- **End** - the time-of-day at the end of the event (defined as when the change in ST segment returns to within 0.5-millimeters different from the patient's baseline)
- **Duration** - the difference between the end and the onset times
- **Max HR** - the maximum heart rate calculated during the duration of the event
- **Max ST deviation Time** - the time-of-day at the event's maximum deviation from the patient's baseline
- **Max ST deviation HR** - the heart rate during the event's maximum deviation from the patient's baseline
- **Max ST deviation Baseline** - the ST segment measurement's deviation from the patient's baseline at the point of maximum deviation

- **Max ST deviation Iso-electric** - the ST segment measurement's deviation from iso-electric at the point of maximum deviation
- **Max ST deviation Slope** - the slope of the ST segment event at the point of maximum deviation (+ indicates upsloping; - indicates downsloping; 0 indicates horizontal)
- **Integral** - this is the calculation that reflects the area under the slope between the ST trend and the patient's baseline during the event

Note: If an event includes both a positive component and a negative one, the integral is actually less than the true area. Although we report the absolute value, the integral calculation can result in a "negative" area, which when added to a positive area can cancel some or all of it.

All of the information listed in the ST event table can be edited by clicking the Edit button to open the ST event edit window and making the changes you desire. To edit an entry, drag across

ST Event Edit window

the existing entry and type the information to replace it. When finished, click OK to save your changes and exit. Click Cancel to close the window without saving the changes.

To add an ST event, click the Add button. The ST Event Edit window opens with blank fields. Type the appropriate information in each of the fields. Click OK to save the event and exit. Click Cancel to exit without saving the event. To delete an ST event from the table, click on the event to be deleted, then click the Delete button. The event disappears.

To print the table, click the Print button. To close the Tables window, click OK.

Documenting ST events

You control what strips are saved to document ST segment events using a combination of settings in the What Strips to Auto Save and How Often Strips Auto Save windows.

Pacemaker analysis

Pacemaker activity is recorded on NorthEast's DR180+ Digital Recorders without distorting the patient's ECG, by removing the effects of the pacemaker spike and replacing it with a pacemaker marker. That marker, when re-introduced to the ECG when the compact flashcard is read by the analysis software, appears as a vertical spike in the precise location of the original pacemaker spike.

For the software to do a proper analysis of the pacemaker activity during the Holter period, the pacemaker settings in the Scanning Criteria window must be set properly. They include:

- **Pacemaker type**, which contains four settings that allow the software to expect certain behavior:
 1. **Not paced** means that the software will not identify any pacemaker spikes, beats or failures.
 2. **VVI** means that each paced beat will be preceded by a single spike. All paced beats are counted as ventricular paced.
 3. **AV sequential** means that paced beats should be preceded by two pacemaker spikes, one atrial and one ventricular.
 4. **DDD** means that paced beats can be preceded by either a one or two pacemaker spikes. Depending on the spike's location relative to the following R-wave, a beat preceded by a single spike will be called either atrial paced or ventricular paced, while a beat preceded by two spikes will be counted as AV paced.
- **Minimum heart rate** refers to the minimum rate allowed by the pacemaker. If the pacemaker does not fire appropriately and there is a RR interval longer than the patient should experience, the Inhibition label appears.
- **Maximum heart rate** refers to the maximum rate initiated by the pacemaker. If the pacemaker fires early, which would result in a faster rate, the Sense failure label appears.
- **Maximum vent. spike to R interval** sets the maximum time between the firing of the second pacemaker spike and the following R-wave. If the second spike appears and is not followed by an R-wave in this amount of time, the Capture failure label appears.
- **Maximum atrial spike to R interval** sets the limit for how long is allowed between a single spike and the subsequent R-wave. If a single spike occurs and the following R-wave is not within this amount of time, the Capture failure label appears.
- **Paced beat and the beat after can be called a SVPB** is a setting that allows you to identify early beats following a paced beat as SVPBs because they were premature, even if they themselves are paced beats. Click on the check box to turn it off and on.

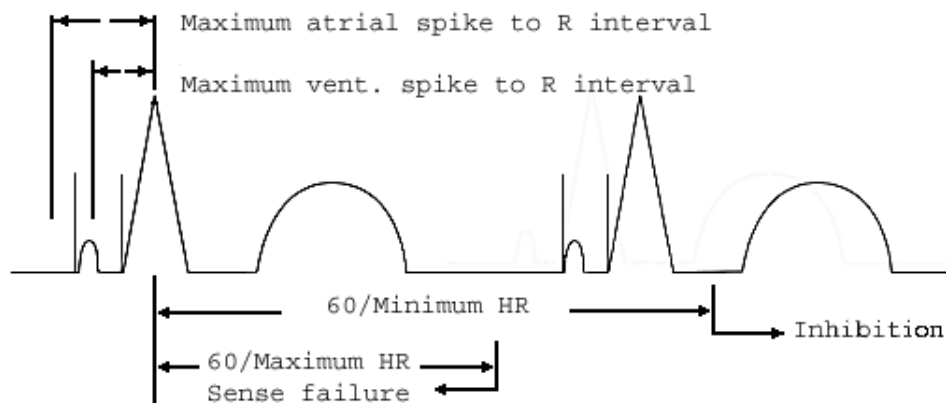


Diagram of pacemaker interval settings

Pacemaker labels

Beats can be identified and counted with the following labels (refer to the diagram on the previous page):

- **A paced** for a beat that is paced just in the atrium. The atrial spike is determined to be the one that occurs well before the QRS, falling before the “Maximum ventricular spike to R interval,” but within the “Maximum atrial spike to R interval.”
- **V paced** for a beat that is paced just in the ventricle. With pacemaker type set to DDD or AV Sequential, the ventricular spike is determined to be the one that occurs during the “Maximum ventricular spike to R interval.” This label also includes all paced beats with the pacemaker type set to VVI and all beats without pacemaker spikes that are manually labelled “Paced.”
- **AV paced** for a beat that is paced in both the atrium and the ventricle, with the atrial and ventricular spikes identified in the same way as described above.
- **Sense failure** means that the pacemaker (1) did not sense a QRS that occurred and (2) fired, resulting in a shorter-than-programmed R-to-spike interval. The label can happen under three scenarios:
 1. Pacemaker type is set to DDD and two pacemaker spikes occur, with less than the “Maximum atrial spike to R interval” between them, and with the second spike more than 20 milliseconds after the QRS.
 2. A single spike is more than 20 milliseconds after the QRS.
 3. The time between the preceding QRS and the next pacemaker spike is less than 60 divided by the “Maximum heart rate;” that is, the pacemaker fired early.
- **Inhibition** refers to inappropriate inhibition of the pacemaker, resulting in a longer-than-programmed RR interval. This label appears if the time between the preceding QRS and the next pacemaker spike is greater than 60 divided by the “Minimum heart rate” setting; that is, the pacemaker fired late.
- **Capture failure** means that the pacemaker has fired, but there is no subsequent QRS within the allotted interval. The label, which falls on the detected QRS after the missing QRS, appears in four scenarios:
 1. The pacemaker type is DDD or AV Sequential and there are two pacemaker spikes, with the time between them less than “Maximum atrial spike to R interval” and the time between the second spike to the QRS greater than the “Maximum ventricular spike to R interval” setting.
 2. The pacemaker type is DDD or AV Sequential and there is only one pacemaker spike, with the time between the spike and the following QRS greater than the “Maximum atrial spike to R interval” setting.
 3. The pacemaker type is VVI and the time between the pacemaker spike and the following QRS is greater than the “Maximum ventricular spike to R interval” setting.

4. There are two pacemaker spikes that are more than the “Maximum atrial spike to R interval” apart and the time from the first pacemaker spike to the following QRS is greater than the “Maximum ventricular spike to R interval” setting.

Pacemaker table

Pacemaker counts are itemized in the Paced table in the Tables window. To display it, click Tables in the Review toolbar, then click on Paced in the Tables list at the right of the Tables window. The Paced table is an interval table and the reported data includes:

- **Time-of-day** - the time-of-day at the start of the interval;
- **Total Beats** - the total number of beats identified and counted within the interval, not including artifact;
- **Time Analyzed** - the total amount of time analyzed during the interval; this does not including periods that are considered to be artifact;
- **Total Paced** - total of the following three fields;
- **Atrial Only** - paced beats that were determined to be paced only in the atrium, not the ventricle;
- **Ventricular Only** - paced beats that were determined to be paced only in the ventricle, not the atrium;
- **AV** - paced beats that were determined to be paced in both atrial and ventricular chambers;
- **Sense Failure** - the number of times sense failures occurred (these are defined on the previous page);

- **Capture Failure** - the number of times capture failures occurred (these are defined on the previous page);
- **Inhibit(ion)** - the number of times the pacemaker was inappropriately inhibited from firing (this is defined on the previous page).
- **Paced%** - the percentage of paced beats out of all beats in that interval.

The fields in this table can be edited as described in the “Editing table entries” section of the following chapter.

4 REVIEW METHODS

The Holter signal saved for a patient can be reviewed on the monitor of your computer in several ways. You can review and edit (1) the most significant events identified during analysis, (2) on-screen full disclosure of all the ECG, (3) graphs showing the heart rate, RR interval and ST data, (4) strips saved for the final report, (5) superimposition, and (6) tables compiled for the report. In addition, if you use Enhanced Plus software, you can also review the templates established during analysis.

Color coding

Throughout the Holter LX software, the ECG is color-coded based on what the system has labeled each beat:

- **Green:** Beats the software has identified as normal.
- **Yellow:** Beats identified as supraventricular premature beats (SVPBs). They have a normal morphology, but fall early.
- **Red:** Beats identified as ventricular premature beats (VPBs). They differ significantly from the normal; they are not necessarily premature.
- **White:** Beats identified as pauses, based on the definition in the Scanning Criteria window. The white overrides any other color that the beat may also qualify for (e.g., red because it's a VPB).
- **Light blue (cyan):** Signal that appears to be contaminated by artifact.
- **Cobalt blue:** Beats identified as paced.

All data must be reviewed carefully to ensure that you agree with the beat labels the software has selected; if you do not agree, you can change them and their color will change appropriately.

In addition to the labels the software can provide for each beat, there are some labels only you can use to relabel beats. These are:

- **Aberrant:** Use this label to identify and counts beats as aberrantly conducted SVPBs. All matches to the template that meet the SVPB prematurity requirement will be counted as

Aberrant SVPBs and colored yellow, like the other SVPBs. This can be used as either a template or a beat label.

- **Questionable (Unknown):** Use this label to separate out beats you cannot identify and keep them from being included in another category. They are colored green, like normals. This can be used as a template or a beat label.
- **T-wave:** Use this label if the software has identified a portion of the signal as a QRS, but it is not. This will remove the beat from the counts and will merge its RR interval with the preceding RR interval. The signal will take the color of whatever beat precedes it. This can only be a beat label.

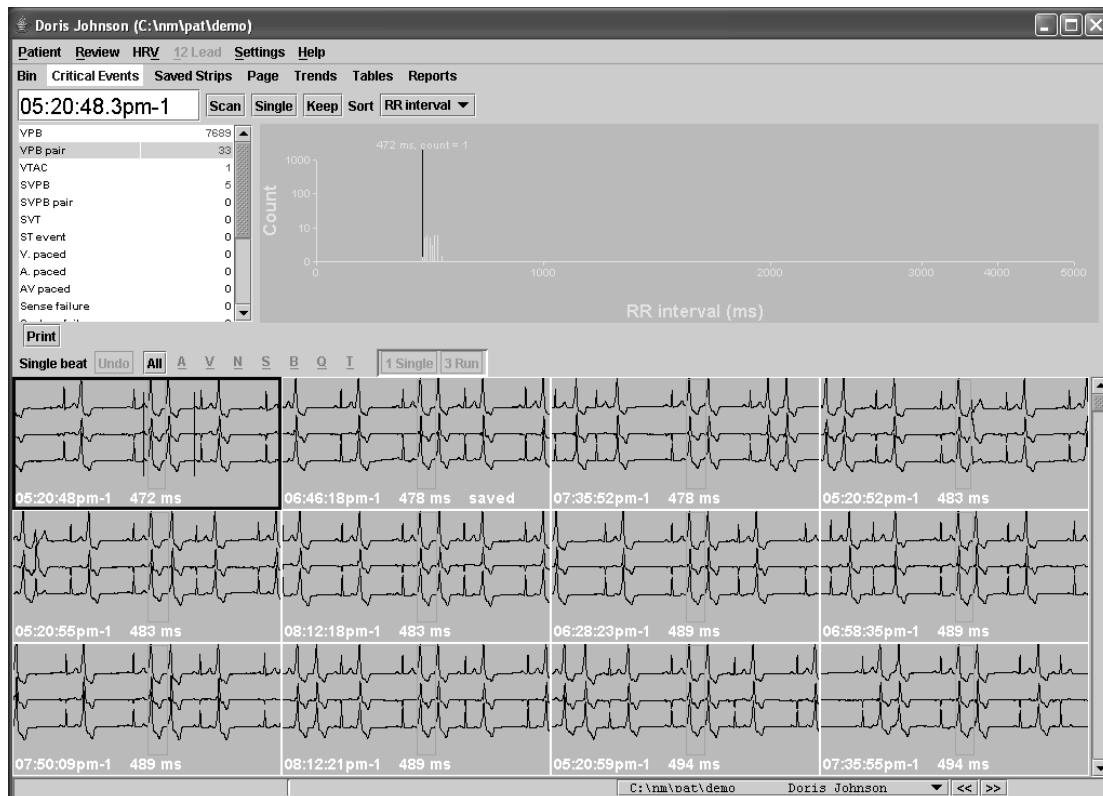
Reviewing Critical Events

The most significant events that occurred during the Holter test appear in the Critical Events window. You can review and edit them as needed in the Critical Events window.

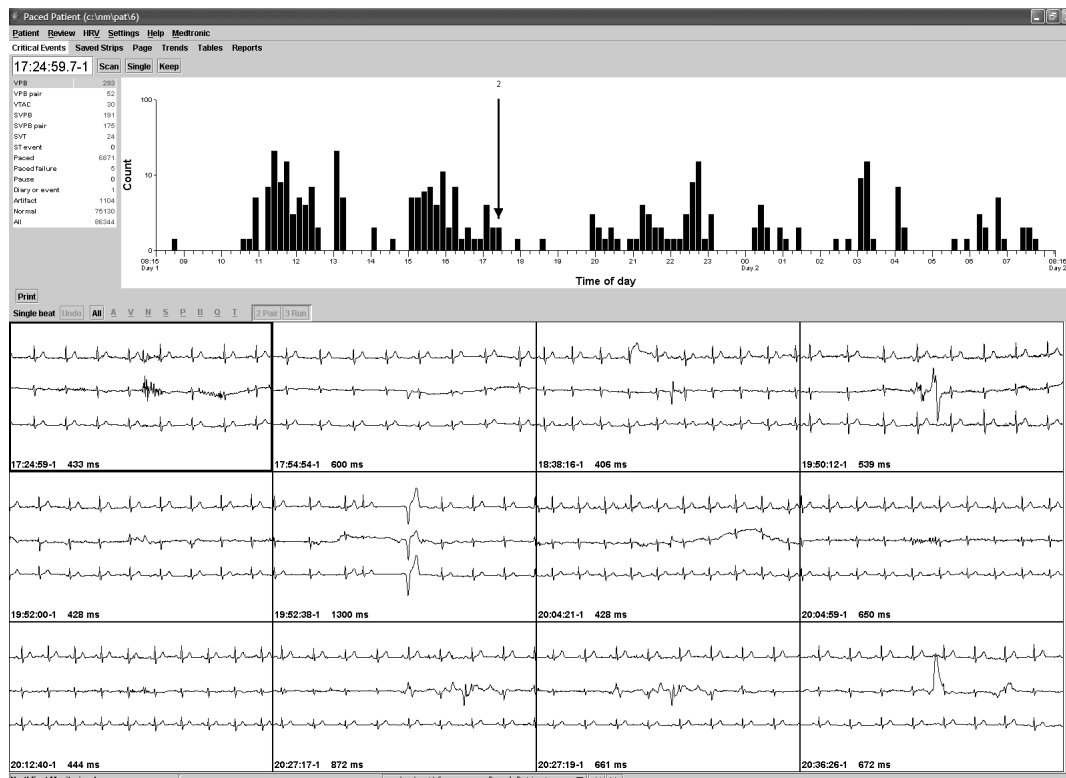
Note: The Critical Events window in the LX Enhanced Edition differs slightly from the Critical Events window in the LX Enhanced Plus Edition. Features described in the following sections will note those differences; if no difference is indicated, there is no difference between the two editions.

Types of Critical Events

The categories that can be displayed appear in the figures on the next page; please note that the categories/choices



Critical Events window in Enhanced Plus Edition - multiple display



Critical Events window in Enhanced Edition - multiple display

VPB
VPB pair
VTAC
SVPB
SVPB Pair
SVT
ST event
V. paced
A. paced
AV paced
Sense failure
Capture failure
Inhibition
Pause
Event
HR strips
Artifact
Normal
All

are different for the Enhanced and the Enhanced Plus Editions. Each type also has a number associated with it - the number of events of that type that were found for this patient. Every event of each type can be displayed, either one (full-sized) or 12 at a time (miniature).

To select a type to be displayed, use the scroll bar to scroll through the list and display your choice, then click on your selection.

Note: A beat that appears in one category of Critical Events does not appear in all other applicable categories. For example, if a VPB appears in VTAC, it does not appear in VPB; if a paced beat appears in Sense Failure, it does not appear in any other paced category. Therefore, do not rely on the counts in Critical Events to provide comprehensive totals.

To move through the displayed episodes, use the PageUp and PageDown keys, the scroll bar, the scroll button on your mouse, or click Scan to automatically move from one display to the next. Click the Scan button again to stop the display.

VPB
VPB pair
VTAC
SVPB
SVPB Pair
SVT
ST event
Paced
Paced failure
Pause
Event
Artifact
Normal
All

Critical Events choices - Enhanced Plus

Critical Events choices - Enhanced

When a single episode is displayed, click the Multiple button to display 12 at a time. When multiple episodes are displayed, the button label changes to “Single;” click that to display just one episode. You can also double-click on a strip to toggle back and forth between the single and multiple displays.

Each event is labeled with time-of-day and RR interval. In addition, if the ECG appears in a strip saved for the printed report, the word “saved” appears to the right of the RR interval.

ST events

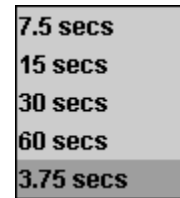
ST events are in the Critical Events list. If you click ST Event, the strips showing the maximum ST deviation during each event are displayed. In addition, an ST event table button appears; that allows you to display a table listing the ST events that were found on this Holter test.

HR strips (Enhanced Plus Edition only)

The HR strips item in the Types field displays all the ECG from the recording, divided up into non-overlapping 7.5-second strips. The heart rate presented with each HR strip is based on just the beats that are present in that strip.

Changing the amount of time displayed

The Display field controls the amount of time that appears in the single-event display. Click on the arrow in the field to show your choices, and click on your choice to change the amount of time displayed.



Choices in Display field

Saving sample strips for the report

As you review the ECG, you can choose to manually save sample strips for the report. The 7.5-second sample strips are printed as full-sized, 25 mm/second ECG on a background grid.

To save a strip containing one of the displayed beats, click on the beat you want at the center of the strip to make it the current beat, and then click Keep; the Keep window opens. To keep it with the current label, click OK. To relabel the strip, type the label in the Description field or select a label from the scrolling list; then click OK to save the strip.

To save multiple strips all with the same label, click on each one to be saved, then click the Keep button and click on the button that indicates multiple strips - it will read “x strips,” with x equal to the number of strips you selected before clicking Keep.

If you decide to close the Keep window without saving the strip, click Cancel.

For more information about the Keep window, see “Saving sample strips for the report” in the Page window section of this chapter.

Sorting episodes within a type (Enhanced Plus Edition only)

The Sort field lets you change the order of the episodes within each type. You can choose “RR interval” to put them in order based on the RR interval, from shortest to longest, starting with the current beat. Unlike RR interval labeling, which labels the interval length from the current beat to the following beat, sorting by RR interval in Critical Events sorts based on the RR interval preceding the current beat; in that way, you can review the most premature beats of a type or the latest beats of a type.

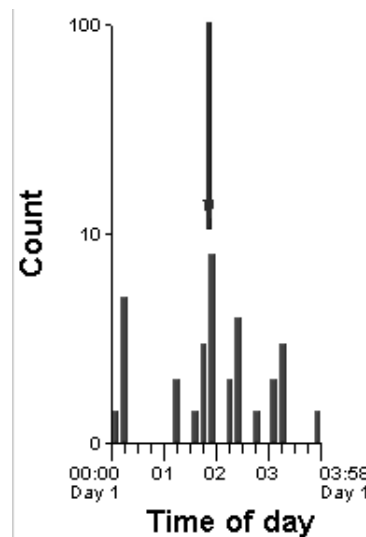
The “Time” setting orders the episodes based on the time-of-day of the event, from earliest to latest.

The “24 hours” setting also orders them by time-of-day, but the histogram at the top of the window is divided into hourly intervals. See the “Histograms” section below for details.

To change the setting, use the scroll bar to display additional choices and then click on your choice.

Histograms

The top portion of the Critical Events window presents a histogram showing the distribution of the events within the type displayed. For the Enhanced Edition, it is always the 24-hour histogram, which orders the events by time-of-day; for the Enhanced Plus Edition, it is either an RR histogram or a 24-hour histogram.



24-hour histogram

The 24-hour histogram shows how many episodes of the displayed type occurred during each 10-minute interval of the recording. The blue arrow is located at the position of the current event. To display the events associated with a different time-of-day, click on the histogram at that time; the appropriate event will appear as the active event in the bottom portion of the window.

The RR histogram plots the length of the RR interval preceding each episode of the displayed type. The number of events is on the vertical axis (with a log

scale) and RR interval (in milliseconds) is on the horizontal axis. The blue marker is located at the position of the current event. To display the event associated with an alternate RR interval, click on the RR interval in the histogram; the appropriate event will appear as the active event in the bottom portion of the window.

Which histogram displays is based on the setting in the Sort field. The settings “RR interval” and “Time” display the RR histogram; the setting “24 hours” displays the time-of-day histogram.

Data fields

The data fields in this window are just like those in all other Review windows. Two blue vertical markers appear within the current episode. The markers can be used to make measurements, which appear in the data fields.

HR (2RR)	108	Time	1.10	ST 1	4.87	2	2.12	3	1.50
----------	-----	------	------	------	------	---	------	---	------

Data fields

Drag the blue markers to appropriate locations to have the data fields display:

- **HR (2RR)** field shows the heart rate calculation based on the blue markers being two RR intervals apart.
- The **Time** field indicates the time (in seconds) between the blue markers.
- The **ST 1** field displays the vertical difference between where the markers intersect channel 1. The left marker should define iso-electric and the right marker should be located

where you want the ST measurement made.

- The **ST 2** field displays the vertical difference between where the markers intersect channel 2. They should be positioned as indicated for channel 1.
- The **ST 3** field displays the vertical difference between where the markers intersect channel 3. They should be positioned as indicated for channel 1.

Click the Both check box to drag the markers keeping them the same distance apart. Click the Both box again to move the markers separately.

To keep the calipers in the same locations as you move through different screens of ECG, click the check box next to Lock; the calipers will stay in the indicated locations unless you move them again. Click to turn off.

Printing the ECG now

To print a strip of ECG centered on a displayed beat, along with a page of full disclosure of the surrounding rhythm, use the Print button. When the Print window opens, click the left-hand button to print with the current beat centered on the page of full disclosure, or click the middle button to print with the current beat on the first line of the page. Click Cancel to close the window without printing.



Print window

Relabeling in Critical Events

All relabeling done in the Critical Events window is single-beat editing. Only the current beat within the selected event is relabeled when you use these relabel buttons:

- **A** for artifact
- **V** for ventricular
- **N** for normal
- **S** for supraventricular
- **B** for aberrant
- **Q** for questionable/unknown
- **T** for T-wave



Relabel buttons

To relabel a beat within the Critical Events window, click on the event to select it; this turns the relabel button from dim to colored. Click one of the colored relabel buttons to relabel the selected beat.

To relabel multiple beats, click on several, then click the relabel button.

To relabel all displayed beats, click the All button, then the relabel button.

In addition, these relabel buttons appear whenever the type displayed is an ectopic event of either ventricular or supraventricular origin:

- **Single** - This will change all beat labels (in the event) to normal except for the current beat, which will be called a single SVPB or VPB, depending on its present label.

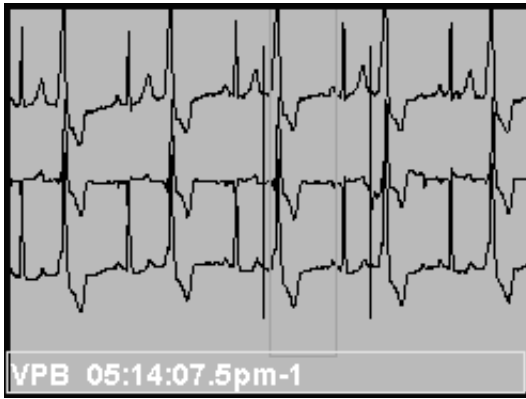
If the present type is SVT, this button will remove the run that was counted and replace it with an SVPB. If the present type is VPB Pair, this button will subtract the pair and replace it with a VPB.

- **Pair** - This will change beat labels so that two sequential beats are called a pair, either an SVPB Pair or a VPB Pair, depending on its present label. If the present type is VPB, this button will change the selected event to be labeled and counted as a VPB Pair. If the present type is SVT, the selected run will be relabeled and counted as an SVPB Pair.
- **Run** - This will change beat labels so that three sequential beats are called a run, either SVT or VTAC, depending on its present label. If the present type is SVPB, a three-beat run of SVT will replace the SVPB. If the present type is VPB Pair, a three-beat run of VTAC will replace the pair.

Reviewing Saved Strips

The report includes full-size, 7.5-second, 25-mm/sec strips on a background grid. Some strips are automatically saved based on the settings in the What Strips to Auto Save window. You can also manually save strips while reviewing the Holter recording.

To review the saved strips, click Saved Strips in the Holter menu. The Saved Strips window displays a miniature version of the strips 12 at a time. Each is labeled with its strip label and the time-of-day at which it occurred. Page through them using either the PageUp



A Saved strip

and PageDown keys, clicking on the up and down arrows of the scroll bar, or using the scroll button on your mouse.

The strips are initially sorted by strip label. To review them ordered by time-of-day, select Time from the choices in the Sort field.

Note: *ST event labels include the channel in which the ST segment change occurred.*

Changing the active strip

At any time, there is only one active strip, the strip outlined in blue. Four fields above the strips refer specifically to the active strip. Those fields include time-of-day, a strip number, HR (heart rate) and HR2 (the second heart rate, that is, the heart rate of a run of VTAC or SVT in the strip).

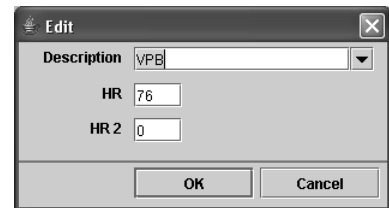
To change the active strip, click on the one you want so that the outline surrounds it. You can also change the active strip by clicking the List button in the toolbar to open the List window. The List window lists each strip label and corresponding heart rate in order of time-of-day. To display a particular strip from the list, click on the appro-

priate entry on the list and click OK, or double-click on the entry. To exit without changing the active strip, click Cancel.

Editing a strip label

To change the label of the active strip, click on Edit in the toolbar. The Edit window opens; it includes a field with the current label of the strip and the heart rate of the ECG in the strip, along with the second heart rate, which is the rate of either SVT or VTAC if it is present. (A second heart rate of 0 indicates that there is no run on the strip.)

You can either type over the existing strip label in the Description field or select



an alternate label by clicking on the ^{Edit window} arrow at the right end of the Description field and selecting a label from the displayed list. If you type the entry, the auto-fill feature appears - as you type, the characters are matched to the preset list and will automatically fill in; if the text that appears is not what you want, continue typing the entry until it displays appropriately. If the label you want is not already on the preset list, you must type the entire entry. Once the correct label appears, press Enter.

To change either heart rate on the strip, click on the field and type over the existing entry.

When you have completed your changes, click OK to save those changes and exit; click Cancel to exit without saving any changes.

Deleting strips

If you decide to delete one or more of the strips from the final report, you can do that in the Saved Strips window. To delete one strip in the Multiple strip display, click on it to make that strip the active one, then click Delete in the toolbar. To delete more than one strip, click on the first strip to make it the active strip; in addition to the blue highlight around the strip, there is also a yellow highlight around the time-of-day, indicating that the strip is selected. Click on any additional strips you want to delete, then click Delete in the toolbar. All of the selected strips (as indicated by the yellow highlight) are now deleted.

When you delete a strip, its label becomes red; strips with red labels are not included in the printed report. To retrieve a deleted strip, click on it and then click Delete in the toolbar again; the label text changes back to yellow.

To delete all of the strips displayed, click the button labeled Del/Undel All. To retrieve all of the strips displayed, click the button again.

Deleting channels from a strip

To delete one or more channels of a strip, but not the entire strip, click on a strip to make it active. Then, click on one of the check boxes labeled Channel 1, 2 and 3. For a particular strip, if a check is present, the channel will be included; if a box is not checked, the channel will be deleted. To delete a

channel from all strips, delete the channel from the active strip, then click All.



Confirm window for deleting channel in All strips

When the Confirm window shown above appears, click Yes to delete the channel(s) from all strips. Click No to cancel the All command.

Replacing a strip with an alternative

Two strips can be replaced by an alternative: maximum and minimum heart rates. The software selects sample strips for those types automatically. If you would prefer to select a different one (perhaps because the selected one contains artifact), click on the strip to make it active; the Alternatives button appears.

When you click the Alternatives button, the Alternatives window opens, displaying other choices for that label. The strips are sorted by heart rate, with the current selection the first one, in the upper left corner.

To select a different strip, click on the strip and then the Select new Alternative button. The window closes and the new strip appears in the Saved Strips window. To exit from the Alternatives window without changing the strip, click the Back to Saved Strips button.

Measuring

The data fields in the center of the toolbar - HR (2 RR), Time, and the ST indicators for each channel - contain data calculated based on the two blue calipers in the active strip. As you drag the blue calipers, those fields change, reflecting the new caliper positions.

To measure a two-beat heart rate, place the calipers two RR intervals apart; the measurement appears in the HR (2 RR) field. To measure ST in any of the channels, position the left caliper in the isoelectric area of the PR interval and the right caliper where you want to make the ST measurement; the measurements for each channel appear in the appropriate fields.

To move the calipers keeping them the same distance apart, click the check box next to Both and then drag the calipers. Click again to remove the mark and move them separately.

To keep the calipers in the same locations as you move through different screens of ECG, click the check box next to Lock; the calipers will stay in the indicated locations unless you move them again. Click again to turn off.

Printing the ECG now

To print a strip of ECG centered on a displayed beat, along with a page of full disclosure of the surrounding rhythm, use the Print button. When the Print window opens, click the left-hand button to print with the current beat centered on the page of full disclosure,

or click the middle button to print with the current beat on the first line of the page. Click Cancel to close the window without printing.

Expanding the active strip

To view a strip more closely, either click Single in the toolbar or double-click on the strip. It then fills the Saved Strips window. Each beat is labeled with either the heart rate (BPM) or the length (in milliseconds) of the RR interval following the beat.

The blue measurement calipers and the related data fields work in this window exactly as those described in the previous section, "Measuring."

All other buttons and fields work in the Expanded display just as they do in the Multiple strip display. Use PageUp and PageDown to display the other strips. To return to the Multiple strip display, click Multiple in the toolbar.

Note: Saved Strips are re-compiled after every Update or Re-analysis, so be sure to make changes to the automatically saved strips only after you have completed all other editing. Any editing of automatically saved strips that occurs before an update or re-analysis will be lost.

Reviewing in the Page window

The Page window allows you to review all of the ECG stored during the recording, like an electronic full disclosure. To open it, click on Page in the Review toolbar. The window is divided into two displays: a miniature, single-channel presentation and an expanded three-channel display with a background grid.

You can toggle the window format back and forth between (1) only the miniaturized ECG and (2) a combination screen (with a single-channel display on the top half and an expanded strip on the bottom) using the Full screen/Expand button.

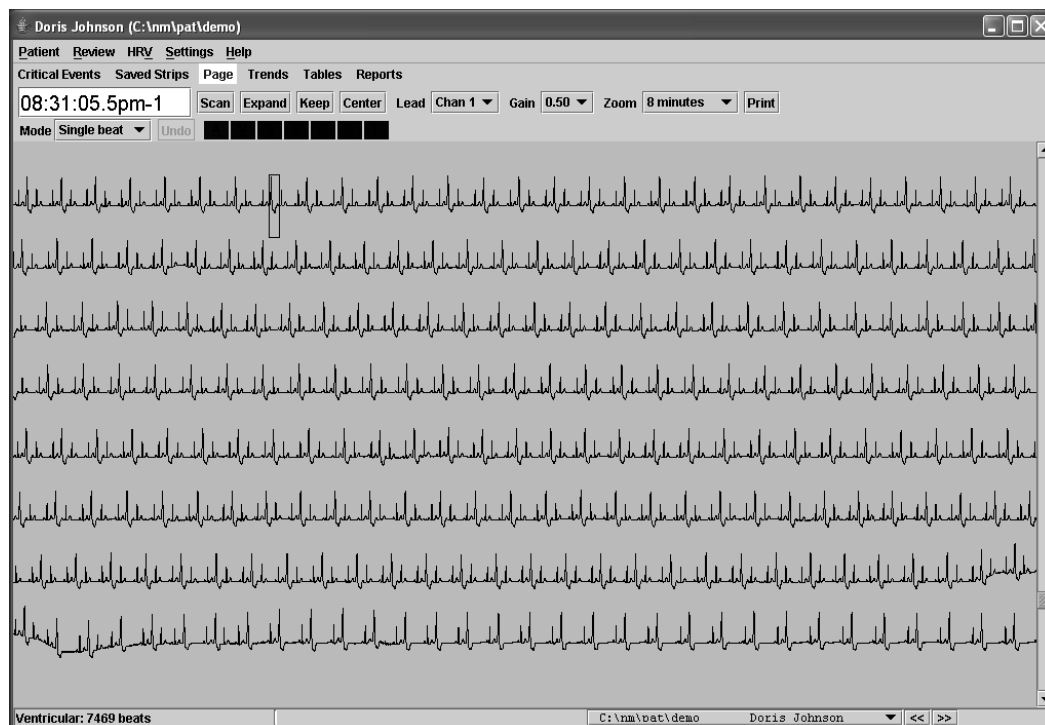
Single-channel page display

The single-channel page display contains a blue highlight box surrounding one of the QRS complexes, the “current” beat. The time-of-day at that beat is displayed in the time field in the upper left corner of the window. The displayed ECG can be adjusted in these ways:

- To adjust the ECG so that the highlighted beat appears in the center of the page, click Center.
- To move the highlight box to a different beat, click on the beat.
- To change the channel displayed, click on the Lead field and select a different channel from the list.
- To change the amplitude of the displayed signal, click on the Gain field and select a different size from the list.

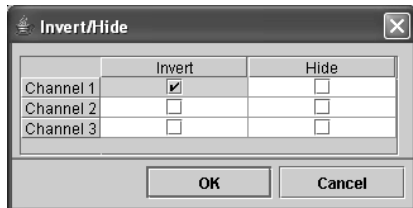


Gain choices



Miniature ECG in Page window - Enhanced Edition

- To change the amount of time displayed on each page, click on the Zoom field and select a different amount of time.
- To invert the signal in a channel or to hide it from view (because the signal in one channel interferes with



Invert/Hide window

your visual review of another channel) go to Review > Invert/Hide to open the Invert/Hide window. Click on the check box for each channel to be inverted; click on it again to return the signal to normal. Click on the check box for each channel to be hidden; click again to return it to normal. Click OK to save any changes and exit. To close the window without saving changes, click Cancel.

In the single-channel display, you can visually review pages of ECG by using the PageUp and PageDown keys, by clicking on the down arrow of the scroll bar, by using the scroll button on your mouse, or by clicking the Scan button. Turn the Scan button off by clicking it again. Control the speed of the scan by pressing + to make it faster and - to slow it down.

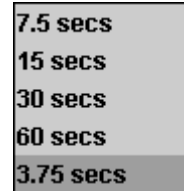
Expanded ECG display

The Expanded display shows three channels of ECG in the bottom of the Page window. To display Expanded ECG, click the Expand button.

The Expanded ECG in the bottom half of the window and the single-channel display in the top half of the window are linked. The Expanded strip is centered on the highlight box in the top half. If you move the highlight box, the ECG displayed in the bottom half changes appropriately.

Note: *If there is oximetry data for a patient, it appears in the Channel 3 area of the Expanded ECG. The color-coded trend (mostly green) shows the SpO2 data and the white trend shows the pulse waveform.*

To change the amount of time that appears in the expanded mode, click in the Display field in the toolbar at the center of the window and select the amount of time to be displayed.



Choices in Display field

To obtain a single-page printout of the ECG on the screen, click Print in the toolbar at the top of the Page window. The Print window appears. To print the ECG with the current beat centered in a single-channel, miniaturized format, click on the Beat centered button; to print with the current beat in the center of the top line of the single-channel, miniaturized format, click on the Beat on top line button; to close the Print window without printing, click Cancel.



Print window in Review windows

Relabeling in the Page display

The type of relabeling performed is determined by the setting in the Mode field. Choices are:

- **Single beat** relabels just the current, highlighted beat to whatever label you choose (for Enhanced Plus, this removes the beat from whatever template and bin it was in and installing it in a new template in its new morphology). When the label changes, so does the color of the beat and how it's counted in the tables.
- **All matches** relabels the beat and all beats that match it to whatever label you choose. (In Enhanced Plus, the template is removed from its present bin and established as a template in a bin in its new morphology.) All matches have the new label and are color-coded and counted appropriately.



Relabel Modes

The relabel buttons include:

- **A** for artifact
- **V** for ventricular
- **N** for normal
- **S** for supraventricular
- **P** for paced (appears only when Paced mode is on in Scanning Criteria window)
- **B** for aberrant SVPB
- **Q** for questionable or unknown
- **T** for T-wave

Note: *Although the S and T labels are available in Page, only a single beat at a time can be relabeled to S or T. If Mode is set to All matches and you use the S or T relabel button, a single-beat edit will be performed.*

To relabel in the Page window, click on the beat to be relabeled, select the appropriate setting for the Mode field, and then click the appropriate relabel button.

To relabel multiple single beats to the same label, click on the first beat, then press the Shift key and click on each additional beat. A blue highlight box surrounds each of the beats to be relabeled; click the appropriate relabel button. This method does single-beat relabeling only.

To relabel a string of beats to the same label, click on the first beat and then drag across to the last beat; the beats will turn magenta. Then click the appropriate relabel button. This method does single-beat relabeling only.

Note: *Whenever you use a relabel button, a message appears in the bottom strip of the window indicating what label was given to the beat and how many beats were relabeled. In addition, error messages appear there whenever you try to relabel inappropriately.*

To undo a relabel, click the Undo button. The labeling reverts to just before the last relabel.

Disabling SVPB count

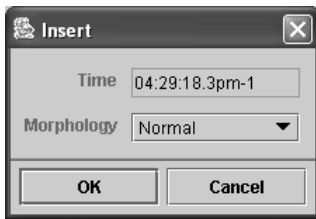
If a patient is in intermittent atrial fibrillation or flutter, you can disable the SVPB counts for those periods. To do so, select the ECG by dragging across it (it turns magenta), then click the SVPB Disable button. All the selected beats turn green, indicating that none of them are called SVPBs. To undo the change, select the ECG again and click SVPB Enable.



Enable/Disable SVPB buttons

Inserting a beat

If while you are reviewing the ECG in the Page window, you see that a particular beat is



Insert window

included in the highlight box of the preceding beat, it means that the beat was missed. This is usually because of very low amplitude, but sometimes because of low slope. To force the system to count the beat, you can use the Insert button in the Expanded Page toolbar.

To insert a beat, first click near the beat so that it appears in the Expanded Page display, then drag or click the left-hand caliper to the location of the missed QRS complex. Click the Insert button in the toolbar in the middle of the window. The Insert window opens, with the time-of-day of the new beat listed in the first field and a beat label in the Morphology field. Click on the arrow in the Morphology field to display the

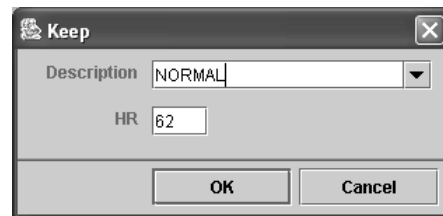
list of label choices and make your selection. Then click OK to insert that type of beat where the left-hand caliper is.

To exit without inserting a beat, click Cancel.

Saving sample strips for the report

As you review the ECG, you can choose to manually save sample strips for the report. The 7.5-second sample strips are printed as full-sized, 25 mm/second ECG on a background grid.

To save a strip, click on the beat you want at the center of the strip to move the highlight box there, and then click the Keep button; the Keep window opens. The Description field contains the current beat label; to keep that label, leave the field as is. To relabel the strip, either type the label in the Description field or select a label from the scrolling list; then click OK to save the strip. The Keep window also



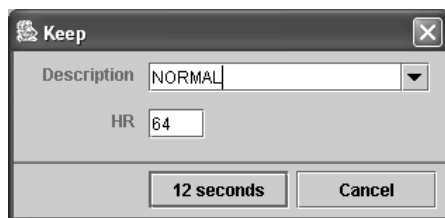
Keep window with OK button

includes two heart rate fields: HR, which equals the heart rate of the background rhythm of the strip, and HR 2, which is the rate of the run (VTAC or SVT) on the strip, if there is one. HR 2 equal to 0 means that there is no run on the strip. Both fields can be edited if

you choose to. Be sure to make any measurements before you click Keep because the calipers are not accessible when the Keep window is open.

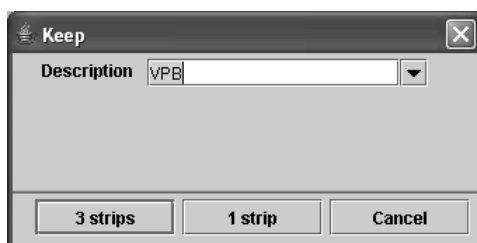
Once the label and the heart rate fields contain the information you want, click OK.

To save strips of an event longer than 7.5 seconds, drag the cursor across the ECG to be saved (the selected ECG turns magenta) and then click Keep. In the Keep window, you can enter the label of the first strip in the series and then click the left button, which indicates how long a time period to be saved. Subsequent strips in the series will be labeled “Continuous (x/n)”



Keep window with time button

(meaning strip number x out of a total of n strips in the series). To save multiple strips, all with the same label, click on a beat at the center of the ECG to be saved, then hold the Shift key down and click on another beat. Then click Keep. In the Keep window, click the button labeled “n strips” to save all the selected examples; click the button labeled “1 strip” to save just the first. All strips will have



Keep window with multiple strip button

the label indicated in the Description field; change it when appropriate. Because the strips are likely to have different heart rates, no heart rate fields are presented.

If you decide to close the Keep window without saving the strip, click Cancel.

Measuring in Expanded Page

The two blue vertical calipers that appear in the Expanded strip in Page (see example on next page) can be used to make a variety of measurements. To measure, drag the calipers to specific locations on the ECG; or click on the ECG to move the closer caliper to that location. To move both calipers while keeping them the same distance apart, click on the Both check box in the center toolbar and then drag or click them to a new position; click the Both check box again to move each caliper separately.

To measure the heart rate on the strip, place the calipers two RR intervals apart; the heart rate appears in the HR (2 RR) field. To measure an RR or a PR interval, place the left caliper at the start of the interval and the right caliper at the end of the interval; the time between them appears in the Time field.

To keep the calipers in the same locations as you move through different screens of ECG, click the Lock check box; the calipers will stay in the indicated locations unless you move them again. Click again to turn off.





Calipers placed two RR intervals apart to measure heart rate

To make ST measurements, place the left caliper in the isoelectric portion of the PR interval, and place the right caliper where you want the ST segment measurement to be made; the vertical distance between where the left caliper intersects the ECG and where the right caliper intersects the ECG will appear in the ST field for each channel (labeled ST 1, 2, 3).

Note: All Review windows are linked by time-of-day. In addition, the Page window is linked to all other Review windows through the right-hand button on the mouse. From any other Review window, a right-click will jump to the Page display, retaining the current beat. After that, a right-click in Page will then take you back to where you originally were, regardless of whether you change the current beat in the Page window.

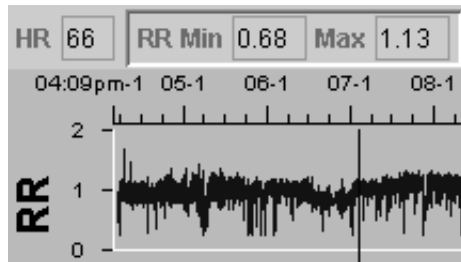
Reviewing the Trends window

Open the Trends window by clicking on Trends in the Review toolbar or by selecting Review > Trends in the primary Holter toolbar. This display differs for the Enhanced and Enhanced Plus Editions. Unless otherwise noted, all features starting with “The blue marker” section apply to both editions.

Trends in Enhanced Edition

The trends present data in 30- or 60-second increments throughout the Holter period, including an RR trend showing the range of RR interval measurements in each minute; the heart rate trend showing the average heart rate for each minute; and 30-second ST segment data for all three channels. If oximetry data was collected, the trend also includes oximetry data in place of channel 3 ST data.

On all of the trends, time-of-day appears on the horizontal axis. RR intervals are plotted so that the range within each minute appears as a vertical line; the top end of the line indicates the longest RR interval within that minute, and the bottom of the line indicates the shortest RR interval within it.



RR trend with min and max indicated

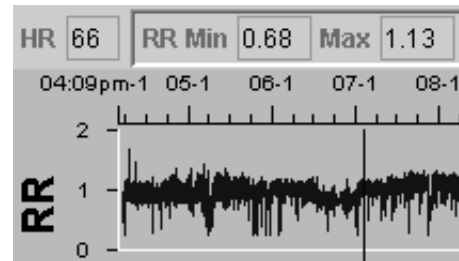
The ST trends include three components for each channel: (1) the patient's baseline ST measurement, that is, the patient's normal ST; (2) the actual measurement made for each 30-second increment; and (3) the slope indicator for each 30-second indicator. The baseline measurement is trended as a blue line, the actual measurement is green, and the slope indicator is a vertical red line drawn from the actual measurement to the measured value at the slope caliper.

The display includes the arrhythmia trend graphs of information from the recording; select ST level from the Type menu to display ST and optional Oximetry trends.

Arrhythmia Trends in Enhanced Plus Edition only

The arrhythmia trends present data in one-minute increments throughout the

Holter period, including the RR trend showing the range of RR interval measurements; the heart rate trend showing the average heart rate; total VPB and VTAC trends; and total SVPB and SVT trends.



RR trend with min and max indicated

On all of the trends, time-of-day appears on the horizontal axis. RR intervals are plotted so that the range within each minute appears as a vertical line; the top end of the line indicates the longest RR interval within that minute, and the bottom of the line indicates the shortest RR interval within it.

ST Trends in Enhanced Plus Edition only

The ST trends present the ST segment analysis data in 30-second increments throughout the Holtered period for all three channels of data. The placement of the ST calipers is automatic unless you re-set them in the Calibration window. See the section "ST segment analysis" in the previous chapter for more detailed information about ST segment analysis.



ST segment and slope measurement data boxes

The ST trends include three components for each channel: (1) the patient's baseline ST measurement, that is, the patient's normal ST; (2) the actual measurement made for each 30-second increment; and (3) the slope indicator for each 30-second indicator. The baseline measurement is trended as a blue line, the actual measurement is green, and the slope indicator is a vertical red line drawn from the actual measurement to the measured value at the slope caliper. If no red line appears, the slope of the ST segment is 0.

For oximetry patients, the channel 3 area of the ST trends contains oximetry data, including (1) a color-coded trend line (colored the same as the beat labels) of SpO2 data on a scale from 60 to 100 percent saturation and (2) a white trend showing pulse oximetry data.

The blue marker

The blue vertical marker is located at the time-of-day of a particular 30-second segment. Click on either trend to move the marker to a different time-of-day. The time-of-day that appears in the large data box indicates the time-of-day at the marker.

The data boxes at the top of the display indicate the data collected for the minute where the marker is located, including heart rate (HR), the shortest RR interval (RR Min), the longest RR interval (Max), the total number of VPBs and SVPBs, and the total number of VPBs and SVPBs that occurred during runs of VTAC and SVT. In addition, the ST data boxes include data

collected for the 30-second interval where the marker is located, including the ST segment measurement for each channel in ST 1, 2 and 3, and the ST slope measurement for each channel in Slope 1, 2 and 3.

The oximetry data appear with the measured heart rate in the SpO2 HR field, the minimum SpO2 measurement in the Min field, and the maximum SpO2 measurement in the Max field.

Asterisks indicate that there is no data for that time period, usually because of artifact.

Relabeling to artifact

If entire periods are contaminated by artifact or if the electrodes were removed early (which generates lots of high frequency noise without ECG at the end of the Holter data), you can relabel continuous periods of data artifact.

In the Trends window, to relabel a continuous period as artifact, click at the time-of-day you want to start rejecting and then drag until the end time. The time period turns magenta. Now click the Artifact button. A message will appear asking whether you mean to relabel the period as artifact. Click Yes to do so. All of the data within that time period is now called artifact, colored light blue, and not included in any of the totals.

To cancel the relabel, click No when the confirmation window appears.

Oximetry buttons

For patients with oximetry data, the Desat(uration) On and Off buttons appear. This allows you to manually identify desaturation events that were not identified automatically. To create a new desaturation event, drag across the Trend window from the beginning of the event to the end. The trend is highlighted in magenta. Press Desat On to identify that period as a desaturation event; the event is automatically entered in the Desaturation table in the Tables window.



Desaturation On, Off buttons

You can undo the change in the Trends window by dragging to select it again and then pressing Desat Off.

Shorten analysis time

If the Holter period ends prematurely, you can either throw out the information as artifact, as described in the section above, or you can shorten the analysis time.

To shorten the analysis time, in the Trends window, click to move the marker to the time-of-day at which you would like to end analysis, then select Review > Shorten analysis time. When the window opens to confirm the command, click Yes to re-analyze the data, stopping at the time indicated. To close without re-analyzing, click No.

Disabling SVPB counts (Enhanced Plus Edition only)

If the patient is in intermittent atrial fibrillation and you want to turn off SVPB counting for certain periods of time, click at the time-of-day at the start of a period and drag the marker to the end of the period. The time period turns magenta. Now click the SVPB Disable button. No SVPBs will be counted during that time period. You can create multiple periods like that, if necessary. If you later change your mind and want to count SVPBs during any of the time periods, repeat the process, but click on the Enable button instead.



Enable/Disable SVPB buttons

Amount of time displayed

You can expand the trends by decreasing the amount of time displayed across a single page. To change the amount of time displayed, click on the arrow in the Hours field and select the number of hours you want displayed per page.

When Hours is set to less than 24 for a 24-hour recording, there are multiple pages of data. To move from one page of data to the next, use either the PageUp and PageDown keys on your keyboard, or the scroll bar.

Reviewing Tables

Tables to be included in the final report include interval tables of general, ventricular, supraventricular, pacemaker data, and oximetry data, along with a table listing episodes of significant ST segment change. Oximetry tables appear only for patients with oximetry data.

To review the tables compiled for a patient, click Tables in the Review toolbar. The listing of what tables are available appears at the right of the screen. The displayed table is highlighted in blue. To display a different table instead, click on its name in the list.

The tables and their fields include:

- **General** - This is an interval table that lists the time-of-day at the start of the interval; the low, mean and high heart rate calculated during the interval (see appendix A for details of heart rate calculations); the total number of beats identified and counted in the interval (this excludes periods of artifact); the amount of time analyzed (this also excludes artifact); the total number of SVPBs; the total number of VPBs; the number of pauses; and a field for manually-entered rhythm comments.
- **Supraventricular** - This is an interval table that lists the time-of-day at the start of the interval; the total number of beats identified and counted in the interval (this excludes periods of artifact); the amount of time analyzed (this also excludes artifact); the total number of SVPBs counted; the number of single
- **Ventricular** - This is an interval table that lists the time-of-day at the start of the interval; the total number of beats identified and counted in the interval (this excludes periods of artifact); the amount of time analyzed (this also excludes artifact); the total number of VPBs counted; the number of single VPBs; the number of VPB pairs; the number of runs of VTAC; the number of VPBs that occurred in runs; and the number of R on Ts (see Appendix A for this definition).
- **ST Event** - This table lists the ST segment events that were detected during the Holter test. Data in this table includes the channel in which the event was detected; the time-of-day at the start of the event; the time-of-day at the end of the event; the duration of the event; the maximum heart rate calculated during the event; the time-of-day at the event's maximum deviation from the patient's baseline; the heart rate during the event's maximum deviation from the patient's baseline; the ST segment measurement's deviation from the patient's baseline; the ST segment measurement's deviation from isoelectric; the slope of the ST segment event at the point of maximum deviation; and the integral of the event.

Note: *Details of ST segment analysis and labels are provided in the “ST segment analysis” section of the previous chapter.*

- **Paced** - This is an interval table that lists the time-of-day at the start of the interval; the total number of beats identified and counted in the interval (excluding artifact); the amount of time analyzed (excluding artifact); the total number of beats counted as paced; the number that were atrial-paced only; the number that were ventricular-paced only; the number that were paced in both chambers; the number of sense failures; the number of capture failures; the number of occurrences of inappropriate inhibition; and the percentage of paced beats.

Note: *Details of the pacemaker analysis and labels are provided in the “Pacemaker analysis” section of the previous chapter.*

- **Oximetry (optional)** - Oximetry data is reported in four tables:

1. **SpO2/HR summary** - This includes the Minimum, Mean and Maximum values of SpO2 and heart rate for the patient.
2. **SpO2 summary** - This provides an overview of the amount of time (hours, minutes, and seconds; and percentage) the patient spent in various saturation ranges.

3. **Heart Rate summary** - This provides an overview of the amount of time (hours, minutes, and seconds; and percentage) the patient spent in various heart rate ranges.
4. **Desaturation** - This table lists the start and end times and total duration of any desaturation events identified by the software (based on settings in Settings > Oximetry) or manually identified in the Trends window.

Editing table entries

To edit information that appears in the tables, you can either use the Edit or the Zero button. In the interval tables (all but the ST event and Oximetry tables), the Edit button opens the Interval Table Edit window that allows you to change information within the data fields for a particular interval. To use the Edit button, first click on a particular interval in a table to highlight it, then click Edit.

The screenshot shows the 'Interval Table Edit' window with the following fields:

- Time beginning:** 12:00pm-1
- Time analyzed:** 00:59:59
- Low HR:** 118
- Mean HR:** 120
- High HR:** 121
- Total beats:** 7200
- Brady time:** 00:00:00
- Brady beats:** 0
- Tachy time:** 00:59:59
- Tachy beats:** 7200
- Pauses:** 0
- Bigeminy beats:** 0
- Total paced:** 0
- Atrial paced:** 0
- Ventricular paced:** 0
- AV paced:** 0
- Sense failure:** 0
- Capture failure:** 0
- Inhibition failure:** 0
- Comment:** (text field)
- Comment thru:** 12:00p...
- Ventricular section:**
 - VPB total: 1
 - VPB singles: 1
 - VPB pairs: 0
 - R on T: 0
 - Early VPB: 0
 - VTAC beats: 0
 - VTAC runs: 0
 - VTAC HR: < 120 >=
 - 3: 0
 - 4: 0
 - 5: 0
 - 6-9: 0
 - 10+: 0
 - # beats <: 0
 - # beats >=: 0
- Supraventricular section:**
 - SVPB total: 0
 - SVPB singles: 0
 - SVPB pairs: 0
 - Aberrant: 0
 - SVT beats: 0
 - SVT runs: 0
 - SVT HR: < 120 >=
 - 3: 0
 - 4: 0
 - 5: 0
 - 6-9: 0
 - 10+: 0
 - # beats <: 0
 - # beats >=: 0

Buttons: OK, Cancel

Interval Table Edit window

Within the Interval Table Edit window, you can click in any data field to type in your changes. Highlight an existing entry and type over it, or click to the right of the entry and backspace to eliminate it and then type your entry.

Editable fields appear with data against a white background. Fields that you cannot edit have a blue background. Those fields include the time-of-day of the start of the interval, the time analyzed, the total number of beats, total paced beats, total VPB count, total VTAC runs, total VTAC beats, total SVPB count, total SVT runs, total SVT beats, and the VTAC and SVT heart rates. The total beat counts are not editable because they are calculated from other field data present in the table; as you make changes to the other fields, the total counts change appropriately.

To save your changes and exit, click OK. To exit without saving changes, click Cancel.

Note: *Be sure to make any changes to the tables carefully. Incorrect information entered in this window can cause inconsistencies in the printed report.*

To completely eliminate all information within an interval, use the Zero button, which opens the Interval Table Zero window. In that window, each data field has an associated check box that determines whether to

include or exclude the data for that field in the tables. To exclude data for a particular field, click on the check box so that a check mark appears, indicating that the field will contain a zero in all interval tables. Click again to remove the check mark.

Click on as many data fields as you want zeroed out in the interval tables, then click OK to exit. Click Cancel to exit without saving any changes.

Select/deselect all buttons are available for each section. Use them to turn on or off all data fields within each specified section - general information, ventricular, or supraventricular.

Printing tables

To print a displayed table, click Print to open the Print window, then click OK to print. Click Cancel to close the window without printing.

Closing the Tables window

Click the OK button to close the Tables window.

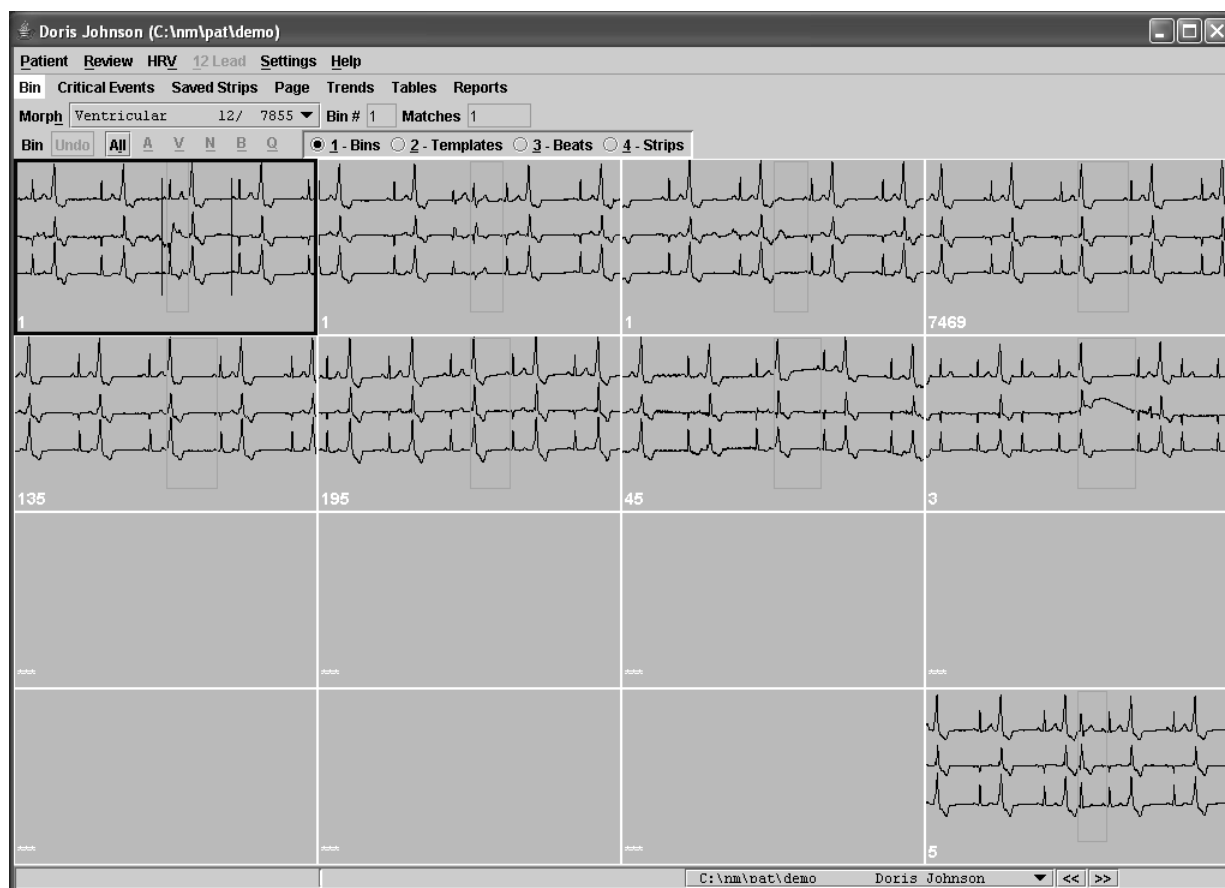
Interval Table Zero window

Reviewing Bins (Enhanced Plus Edition only)

During analysis, the LX software first determines what the patient's normal QRS complex looks like and establishes a template called "normal." Each beat after that is compared to the normal template; matches to that template are also called normal, while a similar but slightly different morphology will establish a new template, also called normal. A QRS complex that differs more significantly from the normal template will establish a template called "ventricular." A new template is established for each different morphol-

ogy identified by the software. Subsequent matches to a template get labeled based on the template label, the timing of the beat, and other criteria.

After analysis, the templates that generally look alike are grouped together in "bins." You can review these bins by morphology, that is, all normal bins or all ventricular bins. Within the Bin window, you can also review by template, displaying all the templates within each bin, one bin after the other. You can also review all matches to each template, displaying them one template after another.



Ventricular bins in Bin window

Description of the Bin window

The Bin window opens with all bins of a particular morphology (normal, ventricular, aberrant, paced, questionable or artifact) displayed, up to a maximum of 16 bins, as shown in the figure on the previous page. The morphology type is indicated in the Morph(ology) field, along with an indication of how many templates of that type were established for this patient and how many total beats were counted as this type. For example, in the figure on the previous page, there are 9 ventricular bins made up of 12 templates, and a total of 7,855 beats matched the templates in those bins.

To change the morphology displayed, click on the arrow in the Morph field to display your choices, then click on the type you want displayed.

In each bin display, the three channels of the center beat are surrounded by an outlined box. That beat is the one that is in the bin; the surrounding ECG is displayed to show how the beat occurred, but is not included in the bin. The number in the left corner of each bin indicates how many total beats matched the templates within that bin.

To select a particular bin, click on it. The time-of-day becomes outlined and the Bin # and Matches field now display data for that particular bin.

Relabeling a bin

To relabel a bin and all of its contents (all templates and matches), click on the bin to select it, then click on one of the label buttons under the Morphology field. The relabel buttons are not active unless one or more bins are selected.



Relabel buttons for bins and templates

The label buttons include:

- **A** for artifact
- **V** for ventricular
- **N** for normal
- **B** for aberrant
- **Q** for questionable/unknown

Note: *No S label buttons appears here because an SVPB matches a normal template, but is early.*

To relabel multiple bins, click on each of the bins you want to relabel and then click on the appropriate relabel button. To relabel all of the displayed bins, click the All button to select all the displayed bins and then click the appropriate relabel button.

To undo a relabel, click on the Undo button. It will restore the bins to their state before the last relabel, regardless of whether it was a single bin, multiple bins, or all bins that were relabeled.

Changing levels in the Bin window

To display the templates within a particular bin, click on the bin and then click on the Templates radio button.

Note: *Moving from one level of the Bin window to the next can also be done by double-clicking on the ECG in the bin, template, or beats display. Each double-click changes the radio button position one button to the right.*



Radio buttons in Bin window

Note: *When a scroll bar appears to the right of a field or window, you have the option of using it or using the scroll button on your mouse, if you have one.*

Template display

The individual templates are presented with two additional pieces of information just underneath each template - the number of matches to the template and the time-of-day the template was established, that is the first occurrence of that template.

When you click to highlight a particular template, the Strip # and Matches fields update to reflect information about the current template.

The template display contains up to 12 templates that matched the current bin. If more than 12 templates fell into that bin, you can access additional pages of templates by using the PageDown key, the scroll bar or the Scan button. If you

use the PageDown key, once you reach the last page of templates in the current bin, PageDown will display the templates that matched the next sequential bin of the same morphology type.

To display the templates in a different bin, click the up and down arrows of the Bin # field.

Relabeling a template

To relabel a template and all matches to it, click on the template to select it (the time-of-day of a selected template is surrounded by a yellow box), then click on a label button under the Morphology field.

To relabel multiple templates, click on each of the templates you want to relabel and then click on the appropriate relabel button. To relabel all of the displayed templates, click the All button to select all the displayed templates and then click the appropriate relabel button.

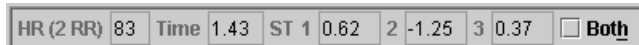
Note: *If there are multiple pages of templates within a bin and you relabel one or more of them, blank spaces are temporarily left where the template(s) originally appeared. After paging up or down and returning, the blank spaces are gone.*

To undo a relabel, click on the Undo button. It will restore the templates to their state before the last relabel.

Beats display

Clicking the Beats radio button displays up to 24 of the beats that matched the current template. Use the Page-Down, the Scan button, or the scroll bar to display additional matches to the template. The display includes the time-of-day each beat occurred, the template number the beats matched (in the Template field), and the total matches to the template (Strip #).

For the current beat, two blue vertical markers appear. The markers can be used to make measurements, which appear in the data fields below the large time-of-day field.



Data fields in Beats and Strips displays

Drag the blue markers to appropriate locations to have the data fields display:

- **HR (2RR)** field shows the heart rate calculation based on the blue markers being two RR intervals apart.
- **Time** field indicates the time (in seconds) between the blue markers.
- **ST 1** field displays the vertical difference between where the markers intersect channel 1. The left marker should define iso-electric and the right marker should be located where you want the ST measurement made.
- **ST 2** field displays the vertical difference between where the markers intersect channel 2. They should be positioned as indicated for channel 1.
- **ST 3** field displays the vertical

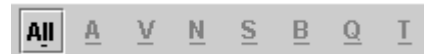
difference between where the markers intersect channel 3. They should be positioned as indicated for channel 1.

Click the Both check box to drag the markers keeping them the same distance apart. Click the Both box again to move the markers separately.

To keep the calipers in the same locations as you move through different screens of ECG, click the check box next to Lock; the calipers will stay in the indicated locations unless you move them again. Click again to turn off.

Relabeling a beat

The Beats window in Bin allows only single-beat editing, which removes a beat from its template and relabels just that beat. To relabel a beat this way, click on the beat to select it, then click on one of the label buttons under the Morphology field.



Relabel buttons for beats and strips

In addition to the relabel buttons defined in the “Relabeling a bin” section on the previous page, the relabel buttons for beats and strips include:

- **S** for supraventricular
- **T** for T-wave

To relabel multiple beats, click on each of them and then click on the correct relabel button.

To undo a relabel, click on the Undo button. It will restore the beats to their state before the last relabel.

Saving sample strips for the report

As you review the ECG, you can choose to manually save sample strips for the report. The 7.5-second sample strips are printed as full-sized, 25-mm/second ECG on a background grid. To save a strip containing one of the displayed beats, click on the beat you want at the center of the strip to make it the current beat, and then click Keep; the Keep window opens. To label the strip, either type the label in the Description field or select a label from the scrolling list; then click OK to save the strip. To close the Keep window without saving the strip, click Cancel.

For more information about the Keep window, see “Saving sample strips for the report” in the Page window section of this chapter.

Printing the ECG now

To print a strip of ECG centered on a displayed beat, along with a page of full disclosure of the surrounding rhythm, use the Print button. When the Print window opens, click the left-hand button to print with the current beat centered on the page of full disclosure, or click the middle button to print with the current beat on the first line of the page. Click Cancel to close the window without printing.

Strips display

The Strips display provides a full-screen display of the current beat. All buttons, fields, and markers work as described in the previous section, “Beats display,” with one addition - the Display field. This controls the amount of time that appears in the full-screen display. Click on the arrow in the field to show your choices, and click on your choice to change the amount of time.

7.5 secs
15 secs
30 secs
60 secs
3.75 secs

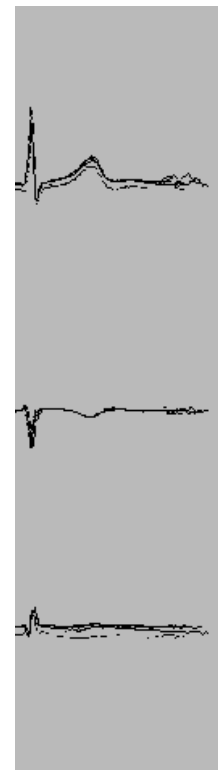
Choices in Display field

Additional features

Superimposition

Holter LX Enhanced/Enhanced Plus software allows you to review the patient's ECG in superimposition mode. In superimposition, each beat is quickly superimposed upon the preceding one in a continuous stream, which allows you to easily identify rhythm changes. Normal beats, VPBs and artifact are superimposed in separate locations in the Superimposition window so that you can also verify beat identification.

To open the Superimposition window, select Superimposition from the drop-down Review menu. Click on Scan to start and stop the superimposition display.



Superimposition

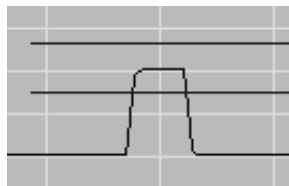
In the display, channel 1 appears on top, channel 2 in the middle, and channel 3 at the bottom. Beats that match normal and paced templates are superimposed at the left side of the window, while beats that match ventricular templates appear in the center, and signal that is considered artifact appears to the right of the window.

Control the speed of the scan by repeatedly pressing + to make it faster and - to slow it down.

Calibration

Although the DR180+ and SD360 Digital Recorders save the patient's Holter signal at standard calibration, you can display the calibration signal at the start of the recording and adjust the height.

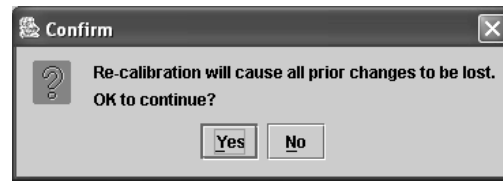
To open the Calibration window, select Calibration from the drop-down Review menu. Three channels of calibration signal are displayed. The two horizontal lines for each channel should be lined up so that one is level with the top of the square wave and one is level with baseline. Drag the lines to move them.



Calibration signal with markers

When finished, click on Done to save the new positions. A Confirm window will appear, asking you whether you

really want to re-analyze using the new marker positions. Click on Yes to continue, and click on No to retain the previous marker locations.



Confirm window after changes in Calibration

Note: *Whenever you make changes in the Calibration window, the signal must be re-analyzed when you exit. If you choose to not re-analyze, the changes are not saved.*

To close the Calibration window without saving new marker locations, click on Cancel.

In addition, you can use the Calibration window to increase the size of a very low-voltage ECG signal or decrease the size of a very high-voltage signal, if the size causes problems during analysis. To increase the size of the signal for analysis, set the horizontal gain markers close together. To decrease the size of the signal for analysis, set the horizontal gain markers far apart.

Note: *If you use the gain markers in this way, the signal is no longer calibrated and no ST measurements are correct.*

ST Markers

The Calibration window is also used to access and adjust the ST markers used during ST segment analysis.

Details of adjusting the markers and all other aspects of ST segment analysis are provided in the “ST segment analysis” section of the previous chapter.

Update

If an Update button appears in your Review toolbar, the Automatically Update feature is turned off in the Preferences window. That means that after some editing changes, you must click the Update button to incorporate your changes. After you make changes that require an update, the Update button will blink red as a reminder that you must at some point click it.

Updates, which are required whenever you change the label of a beat, go back through the Holter data incorporating all new labels and correcting tables, counts, critical events, saved strips, and strip labels appropriately.

You can also choose to update the software using the Update item in the Review menu.

5 12-LEAD PRESENTATIONS

The LX Holter Enhanced/Enhanced Plus software enables you to review and edit 12-lead information recorded on the NorthEast Monitoring DR180+ Digital Recorder using one of the 12-lead recording modes. The 12-lead data and 6-by-2 presentations can then be included in the final Holter report or printed separately. (The 12-lead feature is not available on the SD360 Digital Recorder.)

Recording 12-lead data

To review the 12-lead data collected during a patient's Holter test, the recording mode of the DR180+ must be set to one of the 12-lead settings when the patient is hooked up. The 12-lead settings include:

- “**3 ch hi res 12L 1/3 min**” means that the recording will be three-channel Holter in high resolution, with one sample of 12-lead data saved every three minutes.
- “**3 ch norm res 12L 1/3 min**” means that the recording will be three-channel Holter in normal resolution, with one sample of 12-lead data saved every three minutes.
- “**3 ch norm res 12L 1/min**” means that the recording will be three-channel Holter in normal resolution, with one sample of 12-lead data saved every minute.
- “**3 ch norm 12L 2/min**” means that the recording will be three-channel Holter in normal resolution, with one sample of 12-lead data saved every 30 seconds.
- “**3 ch norm 12L 1/18 sec**” means that the recording will be three-channel Holter in normal resolution, with one sample of 12-lead data saved every 18 seconds.
- “**12L continuous**” means that the recording will save continuous 12-lead data throughout the monitoring period. This setting is for research purposes only. See the DR180+ Operator's Manual for details about using continuous 12-lead data.

Note: The DR180+ records 12-lead data with a sampling rate of 720 samples/second for slightly more than 3 seconds per strip, except when the recorder is set to special research modes.

Reviewing 12-lead data: 12 Lead strips

If 12-lead data is present on the compact flashcard along with a patient's Holter data, the Holter LX Enhanced/Enhanced Plus software activates the 12 Lead menu item in the Review toolbar. If the 12 Lead item is dim, it means that the patient's Holter recording did not include 12-lead data.

LX Enhanced allows you to review the 12-lead data on-screen as strips. This feature is available in the 12 Lead menu in the Review toolbar. To display the 12-lead strips, select 12 Lead > Strips.

The 12-lead data recorded on the DR180+ is displayed in 12 strips per sample. They are from leads I, II, III, aVR, aVL, aVF, and V1 through V6. In the Strips window, you can choose to display them three leads at a time by clicking the Single button or 12 leads at a time by clicking the Multiple button.

Note: In the 12 Lead Strips window, the Single button appears only in the Multiple display and the Multiple button appears only in the three-lead display.

In addition to the ECG, the strips appear with either P, Q, R, S and T markers or ST

markers (iso-electric, j-point and S), depend-



Radio buttons in 12 Lead Strips

ing on which radio button is selected.

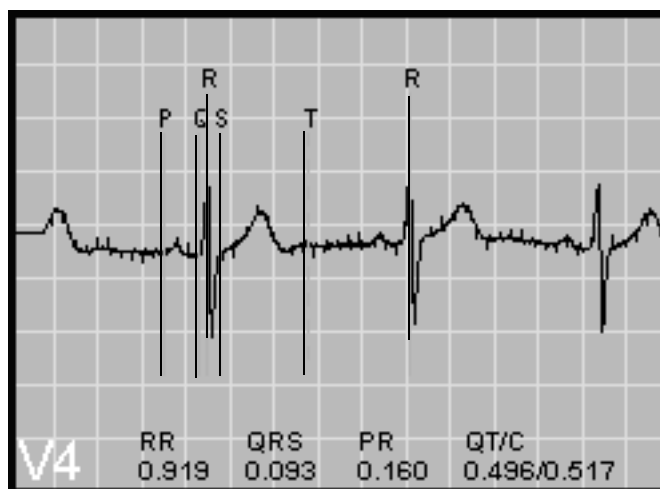
Click on the radio button to the left of your choice to change the display.

Sorting of strips

Strips within the 12 Lead Strips window can be sorted by time-of-day in the order they were saved or by the ST segment elevation or depression measurement in a particular lead. Make a selection from the Sort field to change the order of the strips.

Marker (Caliper) locations

For each beat in each lead, the software determines the approximate positions of the P, Q, R, S, and T calipers, along with the R caliper for the following beat. It also determines the approximate positions of the iso-electric, j-



QRS markers in 12 Lead Strips window

point and ST segment calipers. In addition, it averages each caliper's location across all 12 leads for each individual beat. It is up to you to determine whether those positions are accurate for each beat, and reposition them, if necessary. Appropriate locations for the calipers are:

- **P** - onset of the p-wave
- **Q** - first deflection of QRS complex
- **R** - peak amplitude of QRS complex
- **S** - return to iso-electric after QRS
- **T** - end of T-wave
- **R** - peak amplitude of following QRS complex

Each lead displayed has data associated with it based on the locations of the various calipers. With the QRS markers displayed, the data include:

- **RR interval** - from the R marker on the current beat to the R marker on the next beat,
- **QRS duration** - from the Q marker to the S marker of the current beat,
- **PR interval** - from the P marker to the Q marker, and
- **QT/C** (a corrected QT interval) - from the Q marker to the T marker (at the end of the T-wave).

With the ST calipers displayed, the data include:

- **J-ST interval** - from the J marker to the S marker and
- **ST segment measurement** - the vertical distance between where the I marker intersects the ECG and

where the S marker intersects the ECG.

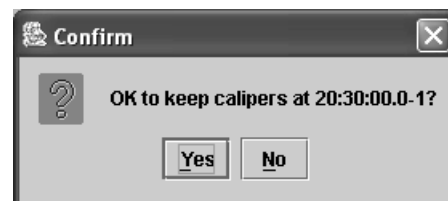
The data displayed are dependent on the current positions of the calipers; if you move the calipers, the data change.

Moving the calipers

Any of the calipers can be moved to alternate locations from within the three-channel display. To do so, if you have Multiple strips displayed, click the Single button.

Within that display, you can reset calipers for all 12 leads at a time. To move a caliper, drag it to its new location. Note that the calipers in all three displayed channels move accordingly; they are also in the new locations when you display all 12 leads.

In addition, as you move calipers, the data fields update using the new position of the calipers. When you exit from the display or move to another strip, a confirmation window appears to ensure you mean to keep the change. To keep the new caliper locations, click Yes. To close the window without saving the new positions, click No.



Confirming new caliper locations

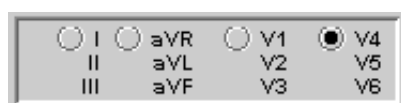
You can also save caliper locations using the Keep Cal button. To do so, display Multiple strips and page to a strip with the calipers located properly (or move the markers in the Single display, then click Multiple to activate the Keep Cal button), then click Keep Cal. The current locations of the calipers will be used.

Changing gain

To change the amplitude of the displayed signal, select from the choices in the Gain field.

Changing the leads displayed

In the three-channel display, you can choose to display leads I, II, and III; aVR, aVL, and aVF; V1, V2, and V3; or V4, V5, and V6. To switch from one group to another, click on the appropriate radio button at the right end of the toolbar.



Radio buttons to select displayed leads

Scanning

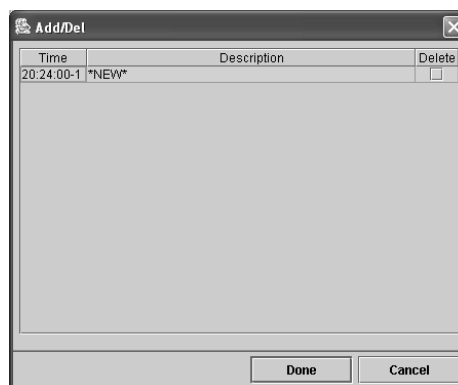
To automatically display one strip after another, click on Scan. Click again to stop the display. You can also move through the strips using the PageUp and PageDown keys.

Displaying a grid

Click on the check box to the left of “Grid” to display a background grid or to turn it off.

Adding/Deleting strips for the report

To add a particular strip to the printed report in a 6-by-2 presentation, display the strip and then click the Add/Del button. The Add/Del window opens. Click on the Description field, then click on the arrow to the right of the field to display a list of choices; click on a choice to select it. Or select the NEW text and type the text you want to appear with this 12-lead data in the printed report, in the 12 Lead Strips modules. Click Done to save the text and the strips for the report. Click Cancel to close the window without saving the strips.



Add/Del window in 12 Lead Strips window

Including/Excluding strips

If you determine that you would like to exclude a particular strip from the 12-lead data (perhaps because of artifact), first display the strip, then click on the Exclude button. The ECG turns magenta and the strip is now excluded. In addition, the Exclude button changes to Include. To retrieve an excluded strip, click Include; the ECG turns green and the strip is now included in measurements, calculations and displays.

Printing 12-lead data and strips

The LX Enhanced software includes these four 12-lead modules that can be included in the printed report:

- 12-lead Trend Graphs
- 12-lead Tables (25 pages)
- 12-lead Strips (25 mm/sec)
- 12-lead Strips (50 mm/sec)

To include a module in the printed report, click on the check box next to it. A check mark indicates that the module will be included in the report. No check mark indicates that it will not be included in the report. To print the 12-lead data without a Holter report, leave the Holter modules not checked and check just those 12-lead modules you want to include.

12-lead Trend Graphs

This is a group of 24-hour trends called “12 Lead Data Graph” that plot:

- **QTd**, which is the QT dispersion, the difference between the longest QT interval and the shortest QT interval for a particular point in time;
- **QTc**, which is a corrected QT interval using the Bazett formula, where $QTc = QT / \sqrt{RR}$;
- **QT**, the QT interval;
- **PR**, the PR interval;
- **QRS**, the width of the QRS complex; and
- **RR**, the RR interval following the measured beat.

12-lead Tables (25 pages)

This module prints out 12-lead data for all the samples taken during the Holter period, which can take up to 25 pages depending on how often 12-lead samples were recorded and how long the recording lasted.

The table includes time-of-day, RR interval following the beat, QT interval, QTC and QTD (as defined above).

12-lead Strips 25 mm/sec

This module prints a 6-by-2 presentation of each 12-lead strip added in the 12 Lead Strip display. See section “Adding/Deleting strips for the report” earlier in this chapter for details about adding strips.

All leads for the strip are printed on a single page, along with the actual data measured for each separate lead for RR, QRS, PR, QT, QTc, and ST in a data box to the left of the signal.

The data box at the top of the page indicates the “average” measurements for all 12 leads combined for that particular beat, along with QTd and heart rate. A minimum of 5 good caliper locations are required to come up with an “average” position. The average measurements include:

- **RR** - This is the time between the average position of one R caliper to the average position of the next.
- **QRS** - This is the time between the earliest Q caliper and the latest S caliper.
- **PR** - This is the time between the earliest P caliper and the average R caliper.
- **QT** - This is the time between the earliest Q caliper and the latest T caliper.
- **QTc** - This is a corrected QT interval from the earliest Q marker to the latest T marker.
- **QTd** - This is the QT dispersion, which is the difference between the longest QT interval and the shortest QT interval.

- **Heart Rate** - This is the heart rate based on the average RR described above.

12-lead Strips 50 mm/sec

This module prints a 6-by-2 presentation of each 12-lead strip added in the 12 Lead Strip display, expanded horizontally, along with ST data for each channel. See section “Adding/Deleting strips for the report” earlier in this chapter for details about adding strips.

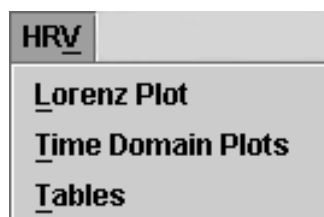
The data box above each presentation indicates the “average” measurements described in the previous section, “12-lead Strips 25 mm/sec.”

6 HRV ANALYSIS

Heart Rate Variability (HRV) software allows you to review information about a patient's normal-to-normal RR interval data in a variety of ways, including Lorenz and time-domain plots. In addition, HRV information is reported in tabular formats of both time and frequency domain. Tables include calculations standard for HRV analysis, including SDNN, SDSD, RMSSD, NN50 count, pNN50, and a variety of indices - HRV triangular, differential and logarithmic.

Reviewing HRV data

Review the HRV data by selecting one of the following items from the HRV drop-down menu in the main Holter menu bar.

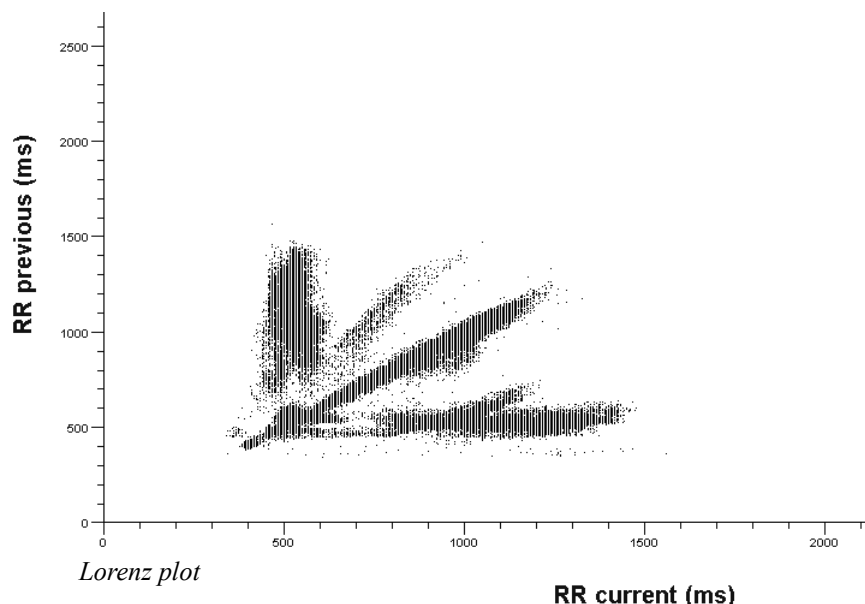


HRV menu in Holter menu bar

Lorenz Plot

These are scatter diagrams comparing the RR interval following the current beat to the RR interval prior to the current beat. You can choose to display all RR intervals, only normal-to-normal RR intervals, only RR intervals on either side of a ventricular ectopic, or

only RR intervals on either side of a supraventricular ectopic. Make your selection in the Morph field by clicking on the arrow and then clicking on your choice.

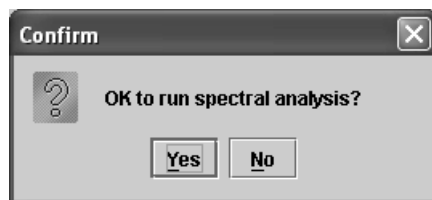


You can change the range on the two axes by making a different selection in the Scale (ms) field. Your choices are 1000, 2000, 3000, 4000, or 5000. Click on the arrow in the field and then click on your choice to change the setting.

In addition, the number of beats plotted on a particular Lorenz scatter diagram is indicated in the Matches field.

Time Domain Plots

Access these by selecting HRV > Time Domain Plots. If spectral analysis has not yet been run for this patient, a query box appears asking whether to run it. In order to view the time domain plots, spectral analysis must have been run for the patient.



Confirmation query

Click Yes to run spectral analysis and then display the requested data; click No to close the window without running spectral analysis or displaying the data.

The time domain plots contain separate trends of these different measurements and calculations over time for each interval:

- **SDNN** - the standard deviation of the normal-to-normal RR intervals;

- **RMS** - the root mean square of the differences between sequential RR intervals;
- **SDSD** - the standard deviation of the differences between sequential RR intervals;
- **NN50** - the number of normal-to-normal RR intervals that were more than 50 milliseconds different from the preceding RR interval;
- **PNN50** - the percentage of normal-to-normal RR intervals that were more than 50 milliseconds different from the preceding RR interval;
- **MeanRR** - the average RR interval within the specified time period; and
- **ProcTime** - the amount of time (in seconds) processed within the interval.

To read specific data from the trends, click on the time-of-day of interest and a blue marker appears. The data fields at the top of the window indicate the specific reading for each calculation at the time-of-day of the blue marker.

To change the number of hours displayed, make your selection from the list of choices in the Hours field. To display the choices, click on the arrow to the right of the field. Click on your choice to select it.

To close the window, click the red close button in the upper right corner.

Tables

Three different tables are available for review. To open the Tables window, select HRV > Tables. Please note that these are accessible using the HRV menu, not the Holter Tables window.

To select a particular table, click on the radio button next to the table's name. To close the Tables window, click OK.

Summary for Time Domain

This tabulates this information for the entire Holter period:

- **SDNN** - the standard deviation of the normal-to-normal RR intervals;
- **SDANN** - the standard deviation of the normal-to-normal RR intervals for each 5-minute period of the 24-hour recording;
- **RMSSD** - the root mean square of the differences between sequential RR intervals;
- **SDNN index** - the mean of the standard deviation of all normal-to-normal RR intervals for all 5-minute segments of a 24-hour recording;
- **SDSD** - the standard deviation of the differences between sequential RR intervals;
- **NN50 count** - the number of normal-to-normal RR intervals that were more than 50 milliseconds different from the preceding RR interval;
- **pNN50** - the percentage of normal-to-normal RR intervals that were more than 50 milliseconds different from the preceding RR interval;
- **HRV triangular index** - an index calculated by first determining the density of beats vs. RR intervals (scaled to a sampling rate of 128 per second), then dividing the total number of beats by the peak density.
- **TINN** - a variation of the triangular index described above.
- **Differential index** - an index describing the differences between the widths of the histogram of differences between adjacent RR intervals measured at the levels of 1,000 and 10,000 beats.
- **Logarithmic index** - coefficient ϕ of the negative exponential $Ke^{-\phi t}$ that is the best approximation of the histogram of absolute differences between adjacent RR intervals.
- **Spectrum slope on log-log plot** - slope of the linear interpolation of the long-term (24-hour) spectrum in a log-log scale. This is the value β of the function $(\log(f)-\alpha)/\beta$ that gives the best estimation of the function $\log(P(f))$ where $P(f)$ is the power density of the spectrum.
- **Ranges values of entire 24 hours** - the values defining each frequency range for this patient. The frequency ranges are abbreviated:
 1. **ULF USR1** stands for ultra low frequency, with the range defined by the user;
 2. **VLF USR2** stands for very low frequency, with the range defined by the user;
 3. **VLF** stands for very low frequency;
 4. **LF** stands for low frequency;
 5. **HF** stands for high frequency;
 6. **Total** stands for the total; and
 7. **Total USR3** stands for the total.

- **Interval length** - the amount of time (in seconds) included in each interval.
- **Number of intervals** - the number of intervals included in the 24-hour recording;
- **Values per interval** - the RR tachogram is sampled every (interval length)/(values per interval) seconds to calculate the long-term (24-hour or procedure length) spectrum.
- **Frequency resolution of short-term spectrums** - this is the size of the step in frequency used to make all calculations for each interval (100 or 300 seconds).
- **Frequency resolution of 24-hour spectrum** - this is the size of the step in frequency used to make all calculations for the long-term spectrum (24-hour or procedure length).

Time Domain

This reports the time domain information for the included data. The table includes:

- **#** - the data number;
- **Time** - the time-of-day of the data;
- **SDNN** - the standard deviation of the normal-to-normal RR intervals;
- **RMS** - the root mean square of the differences between sequential RR intervals;
- **SDSD** - the standard deviation of the differences between sequential RR intervals;
- **NN50** - the number of normal-to-normal RR intervals that were more than 50 milliseconds different from the preceding RR interval;
- **pNN50** - the percentage of normal-to-normal RR intervals that were more than 50 milliseconds different from the preceding RR interval;
- **Mean RR** - the average RR interval;
- **Proc. Time** - the amount of time included;
- **# Beats** - the total number of beats used for the calculations.

Frequency Domain

This reports the frequency domain information for the included data. The table includes:

- **#** - the data number;
- **Time** - the time-of-day of the data;
- **Regular VLF** (very low frequency), **LF** (low frequency), **HF** (high frequency) and **Total** - the actual calculations made for the data indicated;
- **Normalized LF** (low frequency) and **HF** (high frequency) - the relative amount of high versus low frequency data expressed as a percentage of the total.

Printing HRV data

Report modules

- **Time Domain Table.** For each interval, this lists the total number of normal beats along with heart rate variability calculations, including the standard deviation of normal-normal intervals (SDNN), the root

mean square of the standard deviation (RMSSD), the standard deviation of the standard deviations (SDSD), the number of normal-normal intervals that were greater than 50 milliseconds different from the preceding normal-normal interval (NN50), the percentage of normal-normal intervals that were greater than 50 milliseconds different from the preceding normal-normal interval (PNN50), the average normal-normal interval (RR Mean), and the time included in the interval.

- **HRV Time Summary.** This prints a summary of the time domain calculations, as described for the “Time Domain Table” above, plus the maximum standard deviation of normal-normal intervals (Max SDNN), the SDANN, the SDNN index, the HRV triangular index, the Differential index and the Logarithmic index. In addition, the time domain data is plotted across the Holter period, along with two histograms, one showing the RR interval distribution of normal beats and the other showing the RR interval distribution of all beats.

To include a module in the report, the check box next to the module name in the Reports window must contain a check mark. Click on an empty box to add a check mark, and click on a check mark to remove it. To turn all of the modules on or off, click on the All On/Off check box under the report module list; to change them all again, click on the All On/Off check box again.

7 PRINTING

The Holter LX Enhanced/Enhanced Plus software generates printed reports composed of a variety of report modules that can be included or excluded. Each module can be selected individually, depending on your facility's documentation requirements. Modules range from those with clerical information to those with tables of arrhythmia totals and ST data. Sample strips documenting events can be printed in either standard 25 mm/second format or half that size. Full disclosure of any interval can also be included. Some report modules are not appropriate for particular patients and are not included in the list of selectable modules when you go to print the report; for example, 12-lead modules appear only for patients with recorded 12-lead data.

Final Report

Choosing report modules

To access the report modules that can be included in the final printed report, select Reports from the Review toolbar to open the Reports window. The modules that are available for the current patient are listed in the right half of the Reports window. They include:

- **Patient Information.** This has a standard front-page format, with the report heading, the information entered in the Patient Information window, and the Report Summary.
- **Comments Page.** This also contains some clerical information about the patient, along with a large area for comments that were typed in the Comment window of the Report Summary.
- **List of Diary Events.** This lists the time-of-day and symptom for each entry in the Diary Symptoms window accessible from the Patient Information window.
- **Settings Page.** This includes all fields in the Scanning Criteria

	Reports
Patient Information	<input checked="" type="checkbox"/>
Comments Page	<input type="checkbox"/>
List of Diary Events	<input checked="" type="checkbox"/>
General Profile and Trends	<input checked="" type="checkbox"/>
ST Episodes	<input checked="" type="checkbox"/>
List Of Saved Strips	<input type="checkbox"/>
Half-Sized Strips	<input type="checkbox"/>
Full-Sized Strips	<input checked="" type="checkbox"/>
12-lead Trend Graphs	<input checked="" type="checkbox"/>
12-lead Tables (25 pages)	<input type="checkbox"/>
12-lead Strips 25mm/sec	<input type="checkbox"/>
12-lead Strips 50mm/sec	<input type="checkbox"/>
Paced Data Information	<input type="checkbox"/>
Time Domain Table	<input type="checkbox"/>
HRV Time Summary	<input type="checkbox"/>

Report modules in Reports window

window and their settings for this patient.

- **General Profile and Trends.** This gives an overview of the patient's Holter data. The table includes interval data: the time-of-day at the start of the interval; the low, mean and high heart rates within the interval; the total number of beats; the total number of VPBs, VPB pairs, runs of VTAC, SVPBs, SVPB pairs, runs of SVT, and pauses; and the amount of time analyzed in the interval. The trends include minute-by-minute heart rate, VPBs, VTAC beats, SVPBs, and SVT beats.
- **ST Episodes.** This is a list describing the detected ST segment events during the Holter test, along with a trend of the ST segment measurements for each of the three channels and the marker locations that were used for ST segment analysis. Each description includes:
 1. **Ch** - the channel in which the event occurred;
 2. **Onset** - the time-of-day the event started;
 3. **End** - the time-of-day the event ended;
 4. **Duration** - the duration of the event in HH:MM:SS;
 5. **Max HR** - the maximum heart rate during the event;
 6. **Time** - the time-of-day of the maximum ST change during the event;
 7. **HR** - the heart rate at the time-of-day of the maximum ST change during the event;
 8. **mm from baseline** - the maximum change (in millimeters) from baseline during the event;
 9. **mm from iso-electric** - the maximum change (in millimeters) from iso-electric during the event;
 10. **Slope** - the slope of the ST segment during the event; and
 11. **Integral** - the integral (considered to be the area between the curves) between the ST segment trend and the patient's baseline trend during the event.
- **List of Saved Strips.** This lists the strips that are in the printed report, including the time-of-day, strip label, heart rate and heart rate of an event of VTAC or SVT, if appropriate, for each strip.
- **Half-Sized Strips.** This presents the sample strips in a 50 mm/second format that allows 14 strips per page.
- **Full-Sized Strips.** This presents the sample strips in a 25 mm/second format, with three strips per page.
- **12-lead Trend Graphs.** This consists of 6 trends, called 12-lead data graphs, for 12-lead data, which includes QTd, QTc, QT, PR, QRS, and RR intervals. The interval between 12-lead data samples is based on the DR180+ Digital Recorder setting when the Holter test was performed.

Note: See Chapter 5: 12-Lead Presentations for more detailed information about the 12-lead report modules.

- **12-lead Tables (25 pages).** This is a table that reports the numeric data for each 12-lead sample throughout the monitored period. Reported data includes RR, cal RR, QT, cal QT, QTc and QTd.
- **12-lead Strips 25 mm/sec.** This prints a 25 mm/second 6-by-2 12-lead presentation, along with the 12-lead data, for all manually saved 12-lead strips.
- **12-lead Strips 50 mm/sec.** This prints a 50 mm/second 12-lead presentation, along with the 12-lead data, for all manually saved 12-lead strips.
- **Paced Data Information.** This interval table describes the pacemaker activity during the Holter period. This includes the total number of paced beats, the percentage of paced beats, the number of beats that were atrial-paced only, the number that were ventricular-paced only, and the number that were paced in both the atrium and the ventricle, along with capture failures, sense failures, and inappropriate inhibition.
- **Time Domain Table.** For each interval, this lists the total number of normal beats along with heart rate variability calculations, including the standard deviation of normal-normal intervals (SDNN), the root mean square of the standard deviation (RMSSD), the standard deviation of the standard deviations (SDSD), the number of normal-normal intervals that were greater than 50 milliseconds different from the preceding normal-normal interval (NN50), the percentage of normal-normal intervals that were greater than 50 milliseconds different from the preceding normal-normal interval (PNN50), the average normal-normal interval (RR Mean), and the time included in the interval.
- **HRV Time Summary.** This prints a summary of the time domain calculations, as described for the “Time Domain Table” above, plus the maximum standard deviation of normal-normal intervals (Max SDNN), the SDANN, the SDNN index, the HRV triangular index, the Differential index and the Logarithmic index. In addition, the time domain data is plotted across the Holter period, along with two histograms, one showing the RR interval distribution of normal beats and the other showing the RR interval distribution of all beats.
- **SpO2 trend 24 hours (optional).** This prints a compressed trend of oximetry and heart rate data, with 24 hours across one page.
- **SpO2 trend 2 hours (optional).** This prints an expanded trend of oximetry and heart rate data, with 2 hours across each page.
- **SpO2 and heart rate summary (optional).** This table presents the minimum, maximum and mean SpO2 and heart rate values for the monitored period.
- **SpO2 values and Full Disclosure (optional).** This prints two-channel

full disclosure of the ECG annotated with SpO2 values.

- **SpO2 trend and Full Disclosure (optional).** This prints full disclosure of the ECG, along with a trend of the SpO2 data at that time.

To include a module in the report, the check box next to the module name in the Reports window must contain a check mark. Click on an empty box to add a check mark, and click on a check mark to remove it. To turn all of the modules on or off, click on the All On/Off check box under the report module list; to change them all again, click on the All On/Off check box again.

Including a heading on the front page of the report

The Patient Information module of the report includes a report heading so that you can customize the report for your facility. The heading consists of five lines of free-form text, with up to 34 characters per line. To enter text in a line, click on the field and type your entry. Click on each field in turn and type. You can leave any line blank.

Report heading	List
NORTHEAST MONITORING	
Two Clock Tower	
Suite 360	
Maynard MA	
(978) 461-3992	

Report heading in Reports window

If your address comes up automatically, but you would like to change it for a particular patient, you can either

make your selection from the addresses you have associated with different report configurations (see Chapter 10: Configurations for details) or you can use the Delete/Backspace keys to clear what is there, and then type your entry.

To select an address from a different configuration, click the List button. That opens the Report Headings window listing your options. Click your choice to highlight it, then click Copy to close the window and replace the address.

Selecting which strips print in the report

Although both manually saved (those saved using the Keep button in the Review windows) and automatically saved strips appear in the Saved Strips window, they do not all need to be included in the final report. To include just the automatically saved strips, open the Reports window and select Automatic in the Saved strips field. To include just the manually saved strips, select Manual for that field. To include both types, select Both.

Saved strips	
Both	▼
Both	
Automatic	
Manual	

Choices for Saved strips

If the final report is printed including either the half-sized or the full-sized strip module, it will include only those strips designated in the Saved strips field of the Reports window.

Strip annotation

Strips printed in the report can include a beat-by-beat annotation of the ECG. In the Reports window, set the Strip annotation field to indicate how you would like the beats annotated. Your choices are Labels, which are beat labels; Heart rate, which is a beat-by-beat heart rate calculation based on the current-beat-to-following-beat RR interval; and RR, which reports the RR interval (in milliseconds) from the current beat to the following one.



Choices for Strip annotation

To not include any beat annotation, select None in the Strip annotation field.

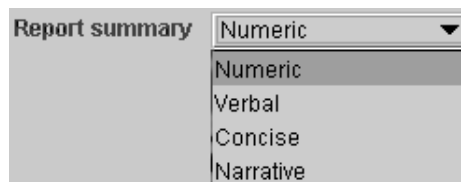
The beat labels consist of:

- **N** for normal
- **S** for SVPB
- **V** for VPB
- **A** for artifact
- **P** for paced (A, V, or AV)
- **E** for aberrant SVPB
- **D** for event marker
- **?** for questionable/unknown

Report summary

The summary that prints on the front page of the report can take one of five

formats. In the Reports window, select Numeric, Verbal, Concise, Narrative or Oximetry (appears only for patients with oximetry data) in the Report summary field to indicate which summary style should appear in the printed report for this patient.



Report summary choices (without oximetry)

The Numeric summary provides a listing of Holter data for the patient. The Concise summary abridges the patient results into a short table and includes sample ECG. The Verbal summary presents the same information using sentences. The Narrative summary provides the information in a more descriptive summary.

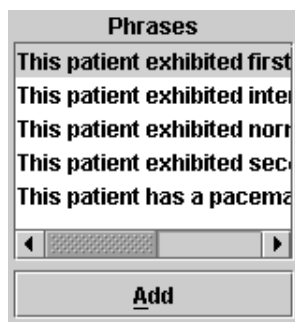
To view and/or edit the summary on-screen before printing the report, make your selection in the Report summary field and then click the View summary button in the bottom of the Reports window; this opens the appropriate Report Summary window.

Editing the Report summary

The Report Summary window displays the information exactly as it will appear on the front page of the report. Every character can be edited, if you choose to do so. You can select the text and then delete it or type over it, or you

can simply add to the information that is already there.

To add comments to the end of the summary, click after **Comments:** and then either type the comment or select a line from the Phrases window in the left portion of the window; after selecting the phrase, click Add to copy it over into the Comments area. The Phrases list appears only if you entered at least one sentence in Patient > Preferences > Summary phrases.



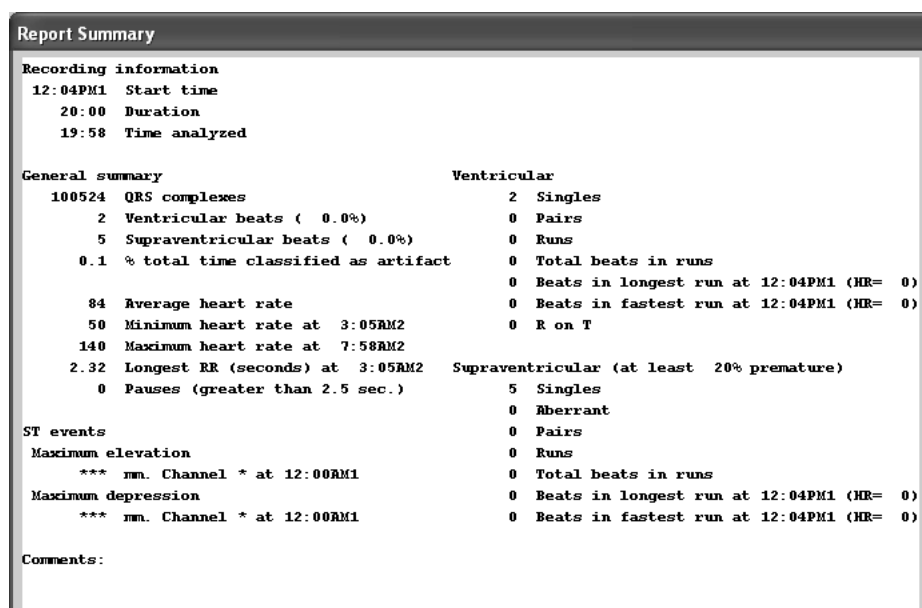
Summary phrases

Note: Because the printed report includes the information from the Report summary exactly as it appears here in the Report Summary window, be sure to make changes carefully.

To access the additional Comment window, click the Comment button, then type the information you would like to appear on the Comments page of the report (typically page 2). Click Front page to return to the previous Report Summary window.

If you start making changes to the text in the Report Summary window, but then decide you would like to revert to the original information, click the Redo button; your changes to the Report Summary window will be deleted and the text will return to the original.

To print the Report summary before inclusion in the final report, click Print.



Numeric summary in Report Summary window

When the information in the window appears as you want it in the final report, click OK to save your changes and exit. Click Cancel to exit without saving your changes.

***Note:** The Report summary is newly compiled after any Update or Re-analysis, so do not make changes here until all other editing is complete. If you make changes here and then make a change that requires an update or re-analysis, you will have to re-enter the changes.*

***Note:** The contents of the Report summary will vary depending on a couple of factors: if the patient has a pacemaker, paced data replaces ST and HRV data; if SVPB counts were disabled, the Report summary states that and excludes supraventricular counts.*

Status indicators

Note that the Status indicators from the Patient Information window also appear here in the Reports window. Use them to keep track of whether a patient's Holter has been edited, printed, and/or verified already. Click the check box to add or remove a check mark.

Full disclosure

Full disclosure is a printout of all the ECG recorded during the Holter monitoring period, in a miniaturized format. Each page is annotated with time-of-day along the left margin.

You can print full disclosure in a variety of formats based on the channels printed and the amount of time printed

on each page. Full disclosure can be printed for a single channel (channel 1 or 2 or 3) or for two channels together on a page (channels 1 and 2, or channels 1 and 3, or channels 2 and 3). It can be printed with 30 minutes of ECG per page or 60 minutes.

Determining what to print in full disclosure

To request a full disclosure printout, select Reports from the Review toolbar. In the Reports window, there is a section with settings that control full disclosure. It includes three fields:

- **Time per page check boxes.** At the top of the section are two check boxes labeled 30 min/page and 60 min/page. To print full disclosure, there must be a check mark in one of these check boxes. Click on the check box to make a check mark appear in it; click on the other check box to put the check mark there and remove it from the first check box. To eliminate a check mark, click again on the check box.
- **Channel(s) field.** To indicate what channel(s) to print in full disclosure, select an entry from the Channel field. Click on the arrow to display

your choices, and then click on your selection.

Full disclosure	
<input type="checkbox"/> 30 min/page	<input type="checkbox"/> 60 min/page
Channel(s)	Chan 2
Intervals	
17:00-1	<input checked="" type="checkbox"/>
18:00-1	<input checked="" type="checkbox"/>
19:00-1	<input checked="" type="checkbox"/>
20:00-1	<input checked="" type="checkbox"/>
21:00-1	<input checked="" type="checkbox"/>
<input type="checkbox"/> All on/off	

Full disclosure area of Reports window

- Intervals to include.** Full disclosure can be printed for each hourly interval, all of them, or whatever combination you select. For each Holter test, the Intervals field lists all hourly intervals in the recording. To include an interval in the full disclosure printout, click on the check box next to the time-of-day at the beginning of the interval. Click on as many intervals as you want printed. To eliminate an interval, click on the check box to get rid of the check mark. To check all intervals on or off, click on the All On/Off check box below the interval list.

Note: The time per page check boxes control how much total ECG is printed per page. If you choose to print two channels of ECG, the 30 min/page setting will print both channels during a 15-

minute time period, and the 60 min/page setting will print both channels of a 30-minute time period.

Reviewing the report

To review the report on screen before printing it, click the Review button at the bottom of the Reports window. This launches the Adobe Acrobat program that generates a pdf file for you to review on-screen.

Note: Although you can choose to print the report from the Acrobat file displayed using the Review button, you must ensure that the Adobe Acrobat settings are appropriate for the Holter report. In File > Print, (1) Print as Image must be turned on and (2) Expand small pages to paper size (version 5) or Fit on page (version 6) must be turned off. Printing the report without the proper settings will result in a non-diagnostic-quality printout.

When you click the Review button, the report compiles and then is displayed on the screen, starting with page 1. The on-screen report appears as a continuous document that can be scrolled through. You see it on the screen in Acrobat Reader. Refer to Acrobat Reader documentation for user instructions.

The report cannot be edited or changed in any way in this display mode, but you can go back to the Review methods (Bins, Critical Events, Saved Strips, Page, and Trends windows), or to the Report Summary or the Patient

Information window to make changes before printing the final report.

Compiling the report using Adobe Acrobat software is also helpful if you want to send an electronic version of the report to a different site that has no Holter LX software. You can send the pdf file created, and the other site can use Acrobat Reader software to print the report.

Printing

When the fields within the Reports window are set properly for a patient, click the green Print button at the bottom of the window to compile and print the report. If you turned on some of the report modules, those print first, followed by any full disclosure you have selected.

To cancel printing after clicking the Print button, click Cancel. Whatever portion of the report that has been compiled prints, and then the rest of the report is canceled.

Note: Sometimes when you click the Print or Review buttons in the bottom of the Reports window, a confirmation window asks, “OK to use the previously compiled report?” That means that a report has already been compiled for this patient. If you are sure that no changes have been made to any Holter setting or any information in the report, click Yes to print a report identical to the previously compiled one. If you are unsure whether any changes have been made, click No; a new report will compile and then print.

At any point after printing the report, you can still edit the information and retrieve additional strips, and then print out the report again.

Closing the Reports window

At any time, you can save changes to the Reports window settings, but exit without printing the report, by clicking OK. Or, to exit without saving any changes to the settings, click Cancel.

8 PREFERENCES

You can customize certain parts of the Holter LX Enhanced/Enhanced Plus software to better suit the needs of your facility. The customization options range from entering the names of physicians who order Holter tests - so that you don't have to type them in each time - to which Review window should come up automatically at the end of analysis.

Preferences window

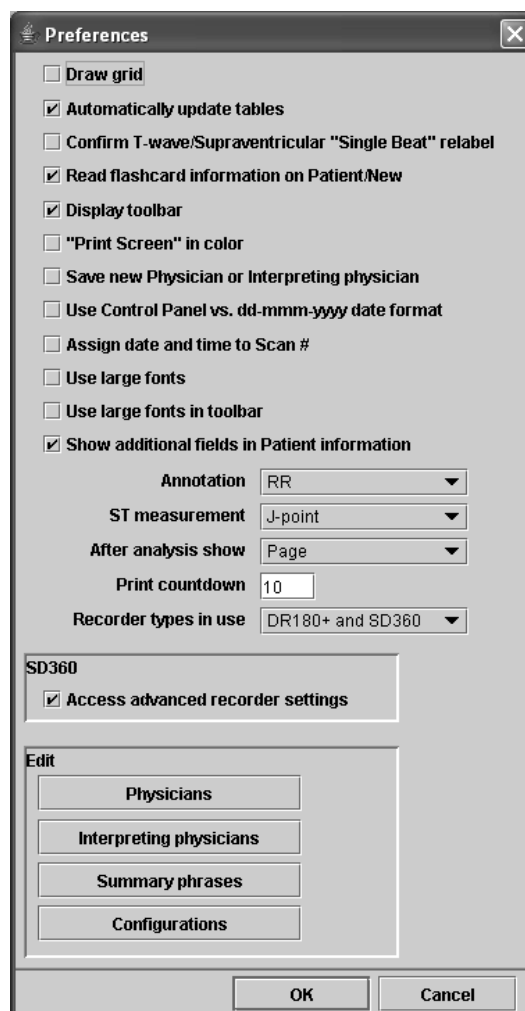
To open the Preferences window, select Patient > Preferences. Please note that the Preference window in LX Enhanced Plus differs from the one in LX Enhanced (see the figure of the Preferences window of Enhanced on the following page). These customization options are available:

Draw grid

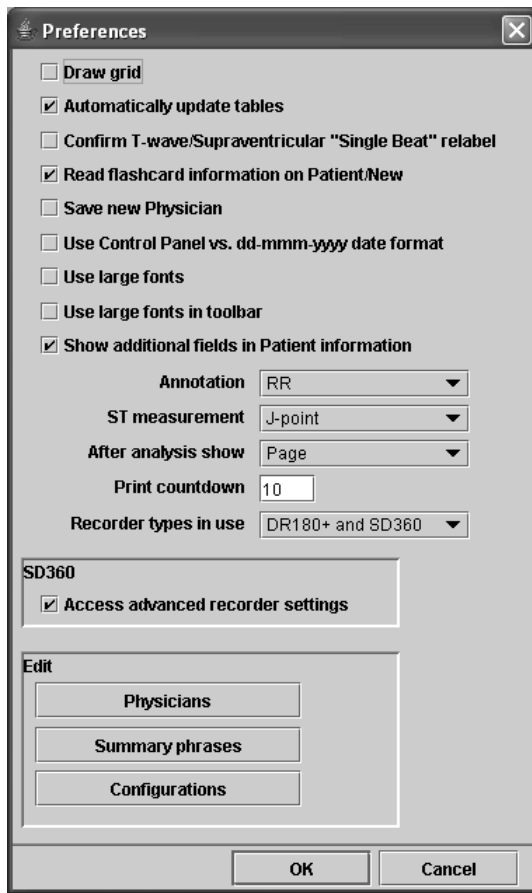
You can choose whether or not there is a background grid behind the Expanded strip displayed in the Page window. Click on the Draw grid check box to change the setting. A check mark indicates that a light grid will appear. No check mark means that the grid will not appear.

Automatically update tables

A check mark should appear in the check box so that the software automatically updates counts, tables and strip labels after you relabel a beat, template or bin in any of the Review windows. If it does not



Preferences window - Enhanced Plus



Preferences window - Enhanced

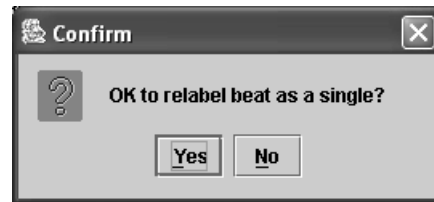
automatically update, you must manually run an update after making changes.

Note: *If this setting is off and you make a change that requires an update, a blinking red Update button will appear in the Review toolbar. To manually run an update after making changes, click on the blinking red button or select Review > Update.*

Confirm T-wave/Supraventricular "Single Beat" relabel

Relabeling a beat to a T-wave or SVPB can only be performed at the Single

beat level, regardless of the Relabeling Mode setting in the Page window. When you relabel a beat to one of these, the software can remind you that only a single beat is being relabeled. If a check mark appears in this check box, a Confirm window appears.



Confirm window

Click on Yes to do a single beat relabel of the highlighted beat. Click No to close the Confirm window without relabeling the highlighted beat.

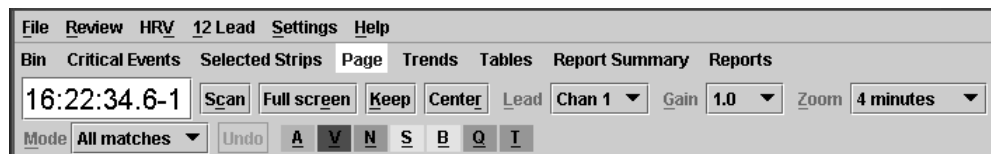
Read flashcard information on Patient/New

When you create a new patient entry by selecting Patient > New from the main menu and the Patient Information window opens, the flashcard/SD card in the card reader can be read immediately, if this setting is on. If this setting is off, the data on the flashcard is not read until you click the Copy flashcard button in the Patient Information window.

Note: *If this setting is on, you must insert the flashcard/SD card into your computer's card reader before a new patient record can be opened. If you select Patient > New without first inserting the card, you will not be able to continue for this patient until the card is inserted.*

Display toolbar (Enhanced Plus edition only)

The Holter LX software has three levels of toolbars. The first contains the buttons Patient, Review, HRV, 12-Lead, Settings, and Help. The second level, which we call the Review toolbar, contains buttons to open the different Review windows and the Reports window. The third level includes the various toolbars that appear with buttons and fields appropriate to whatever Review window is open.



Three levels of toolbars

All of the choices in the Review toolbar are also available in the drop-down menu of Review in the first-level toolbar. If you prefer to eliminate the Review toolbar and make your selections from the drop-down Review menu, turn this setting off. A check mark means the toolbar is displayed; no check mark indicates that the toolbar is not displayed.

“Print Screen” in color (Enhanced Plus edition only)

If you have a color printer and want to print out screen displays in color, turn this setting on. Then when you select Patient > Print Screen, the printout is in color. A check mark means the output

to the printer is in color; no check mark means the output is in black and white.

Save new Physician (or Interpreting physician in Enhanced Plus only)

This field allows the software to ask you whether to add a new physician (or interpreting physician) name to the appropriate list when you close the Patient Information window after typing a new name in the field(s).

Use Control Panel vs. dd-mmm-yyyy date format

To use the date format used throughout your computer system instead of the format provided by Northeast Monitoring, put a check in this check box.

12-Feb-1900

NorthEast date format

To change the date and time format used throughout your computer system, select either: (1) Start > Settings > Control Panel > Regional and Language Options or (2) My Computer > Control Panel > Regional and Language Options. Use the Customize button and the Time and Date tabs to display your options for each field.

Assign date and time to Scan # (Enhanced Plus edition only)

This indicates whether a Scan # is automatically assigned to a patient record. When this feature is turned on, a date-and-time stamp is entered in the Scan # field whenever a New patient is created.

This setting also allows an auto sequencing feature that includes a combination of the date/time stamp plus an assigned number (starting at 00001) in the Scan # field. To implement the auto sequencing feature, you must change the entry in the Scan # field in the Configuration program. See Chapter 10: Configurations for details.

Use large fonts

This determines the size of the font used throughout the software. A check mark indicates that a large font is used for all menu items, selections and text.

Use large fonts in toolbar

This determines the size of the font used in the Holter Review toolbar. A check mark indicates that a large font is used for the Review items.

Show additional fields in Patient Information

The two fields Interpreting physician and Analyst in the Patient Information window are optional. If you want them to appear in the Patient Information window and on the front page of the final report, this setting should be on. If you do not want them, this setting should be off.

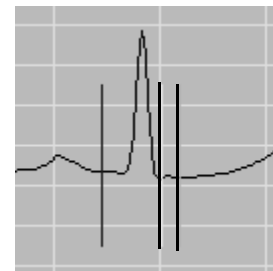
Annotation

Indicate here whether the beats in any on-screen, expanded strip should be labeled with a beat-by-beat heart rate calculation or RR interval length. The annotation refers to the RR interval starting at the R-wave under the label.

Click on the arrow in the field to display your choices. Click on your choice to select it.

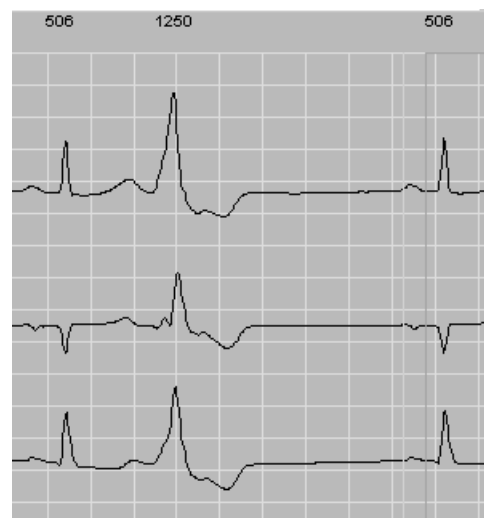
ST measurement

ST segment analysis can be performed with the ST segment measurement made at the position of either of the two right-most ST markers. The middle marker identifies the J-point and the one at the far right is the ST segment marker. Indicate in this field which marker should be used for ST segment analysis.



Positions of ST markers

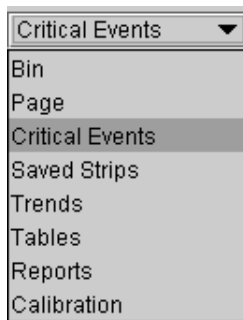
Click the arrow in the field to display your choices, then click your choice.



Beats with RR interval annotation

After analysis show

This field allows you to determine which window is displayed upon the completion of analysis. Your choices include any of the Review windows and the Reports window. To change the setting, click on the arrow in the field to display the list of choices, then click on your selection.



Choices for display

Print countdown

If the “After analysis show” field is set to Reports, upon completion of analysis, the software will display the Reports window for this amount of time (in seconds), after which the report will print. During the print countdown, press any key to prevent the report from printing.

Recorder types in use

This should be set based on whether you use DR180+ or SD360 recorders, or both. Select one of the following: DR180+ and SD360, DR180+ only, or SD360 only. This setting determines what your choices are when you go to format a flashcard/SD card before recording a new patient.

Access advanced recorder settings

This should be on (with a check mark) so that you can make changes to how the SD cards are formatted for use in the SD360 recorder. If you want to not allow changes to the format used, turn this setting off (no check mark).

Edit fields

In the LX Enhanced edition, you are able to customize the entries for the Physician field that appears in the Patient Information. In the LX Enhanced Plus edition, there are two fields that can be customized: Physician and Interpreting physician. Entries in those fields can be preset so that you can make a selection from a list instead of typing the physician name in for each Holter test. In addition, using the Save new Physician or Interpreting physician setting described earlier in this chapter, as you add new names in the Patient Information window and then exit from Patient Information, the system can ask whether to add each new name to the appropriate list.

Physician names

To add a name to the list in the Physician field of the Patient window, go to Patient > Preferences > Physicians. In the Edit physician name window, click on the first line and type the name as you want it to appear in the report. To enter another name, click on the line below the first and type that name. Use the scroll bar to access additional lines.

When you have entered as many names as you need, click OK to close the Edit Physician Names window.



Physician list in Patient Information

To exit without saving changes, click Cancel. To delete an entry, click on the line so that the field is outlined and then click Delete.

Interpreting physician names (Enhanced Plus edition only)

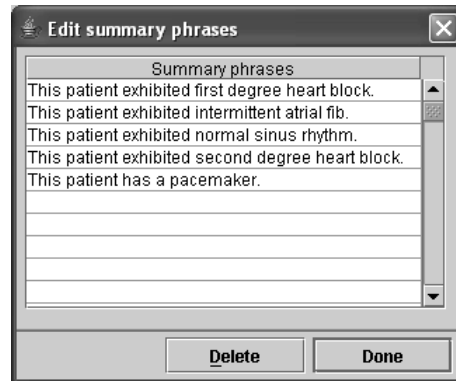
To add a name to the list in the Interpreting physician field of the Patient Information window, go to Patient > Preferences > Interpreting physicians. In the Edit Interpreting physician names window, click on the first line and type a physician's name. To enter another name, click on the line below the first and type the name. Use the scroll bar to access additional lines. When you have entered as many names as you need, click OK to close the Edit Interpreting physician names window.

To exit without saving changes, click Cancel. To delete an entry, click on the line so that the field is outlined and then click Delete.

Summary phrases

You are able to customize entries for the Comments area of the Report Summary section of the printed report using this button.

To add a sentence, select Patient > Preferences > Summary phrases. Click on a field and type a sentence as you want it to appear in the Report Summary. When all sentences are complete, click Done. To delete a line, highlight it and then click Delete.



Edit summary phrases window

The sentences will be available for you to select when you display Reports > View Summary, so that you don't need to re-type common phrases.

Configurations

Click this button to launch the Configuration program that allows further customization of the Holter LX Enhanced/Enhanced Plus software. Details appear in Chapter 10: Configurations.

9 MANAGING PATIENT REPORTS

Making room for new patients

When the software has saved the maximum number of patients allowed by your system, you must delete old patient reports to make room for new ones. If you want to archive an electronic version of each report, make sure you back up a patient report before you delete it.

To delete a patient report from the patient list, go to Patient > Open to display the list of patient records currently in the Holter LX software. In the Open Patient window, click on a patient name to highlight it and click the Delete button. When the Confirmation window appears, click Yes. That slot in the list will now be available the next time you select Patient > New.

To delete multiple sequential patient reports in the Open Patient window, click on the first report to be deleted, then drag down to the last one you want deleted. With multiple patient names highlighted, click the Delete button. When the Confirmation window appears, click Yes.

To close the Confirmation window without deleting any patient reports, click No.

Backing up patient reports

To back up patient reports in the directory before deleting them to make room for new patient reports, go to Patient > Open and click the Backup button to open the Backup window, which displays the Backup tab.

From the list of patients in the top half of the Backup window, click on the patient report you want to back up; if your patient list is longer than the window display, use the scroll bar to display additional patient reports. To back up multiple sequential patient reports, click on the first report to be backed up, then drag down to the last one you want backed up. With the appropriate patient(s) selected (that is, highlighted), click Backup again. A condensed version of the report is created and saved.

What gets saved

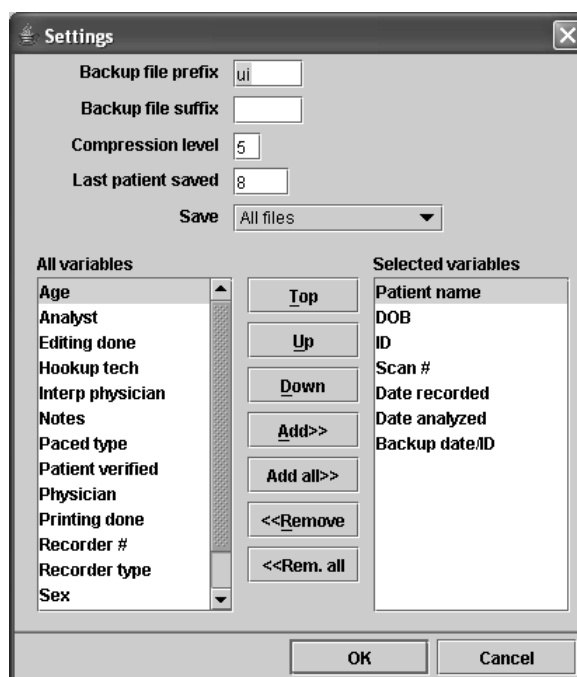
To determine how much of the patient data is saved in the backed up report, the program refers to the entry in the Save field of Backup > File > Settings.

The Save field in the Backup Settings window contains two choices: (1) “All files” will compress all patient data, including the entire Holter recording; and (2) “Reports only” will save an electronic version of the patient’s printed Holter report, including ECG strips, but not the entire recording. By doing an “All files” (full) backup, the

patient’s Holter data can be re-analyzed at a later date.

To change the entry, click on the arrow to the right of the field and then click on your choice. Click OK to close the Settings window. The type of backup report to be saved appears in the Save field of the Backup tab.

Once a patient report has been backed up, the type of backup is indicated in both the Open Patient window and in the Status window within the Patient Information window. In the Open Patient window, a full backup is indicated as “Full” in the Type column; a backed up report is indicated as “Report.” In the patient’s Status window, the Backup field displays either “Full” or “Report,” if the report has been backed up; it is blank if it has not.



Settings window in Backup

Automatic file name

The file name of the backed up report is automatically assigned as a number followed by the “zip” extension. The assigned number is the one following the entry in the Last patient saved field of the Backup Settings window. The software automatically keeps track of the numbers it assigns and updates this field, but you can over-ride it by entering a different number and clicking OK.

Note: Make changes here carefully. If you enter a new number that is smaller than the number listed, the backup process will reuse a file name and over-write the previously saved patient report. Unless that patient report has been transferred elsewhere, it will be permanently lost.

Assigning a backup file name

The Settings window in the Backup program allows you to include a prefix or suffix on the numeric file name given to a backup report. If you assign a prefix or suffix to a particular patient group (for example, all the patients of a particular physician) this feature means that later you can easily identify which reports are in that group.

To include a prefix or suffix to the backup file name, enter up to four characters in the appropriate field of the Settings window before saving the patient report. If no prefix or suffix is specified in the Settings window, the backup file name will be the next sequential number in the backup series, with the extension “zip.”

The size of a backup file

The Compression level field of the Settings window in Backup allows you to control the amount of compression performed when saving the backup file. The range is from 1 to 9, with 1 being the least compressed and 9 the most compressed. That makes 1 the quickest backup process, and 9 the longest.

Customizing the Backup directory

The Backup patient directory (on the Backup tab of the Backup program) can be customized to include only those fields you need to track your patients’ backed up records. Use the fields and buttons in the bottom half of the Backup > File > Settings window to establish which fields appear as column headings in the Backup directory. Those variables (headings) in the left-hand column will not be included; those in the right-hand column will be included. Use the buttons in the center - Add, Add all, Remove, and Remove all - to move variables (headings) from one column to the other. Rearrange those in the right-hand column using the other buttons in the center - Top, Up, and Down.

Note: We recommend that if you customize the Backup directory, you do so only before backing up any patient records. Inconsistencies will result if you back up some reports using one set of headings and other reports with a different set of headings.

Where the backup file is saved

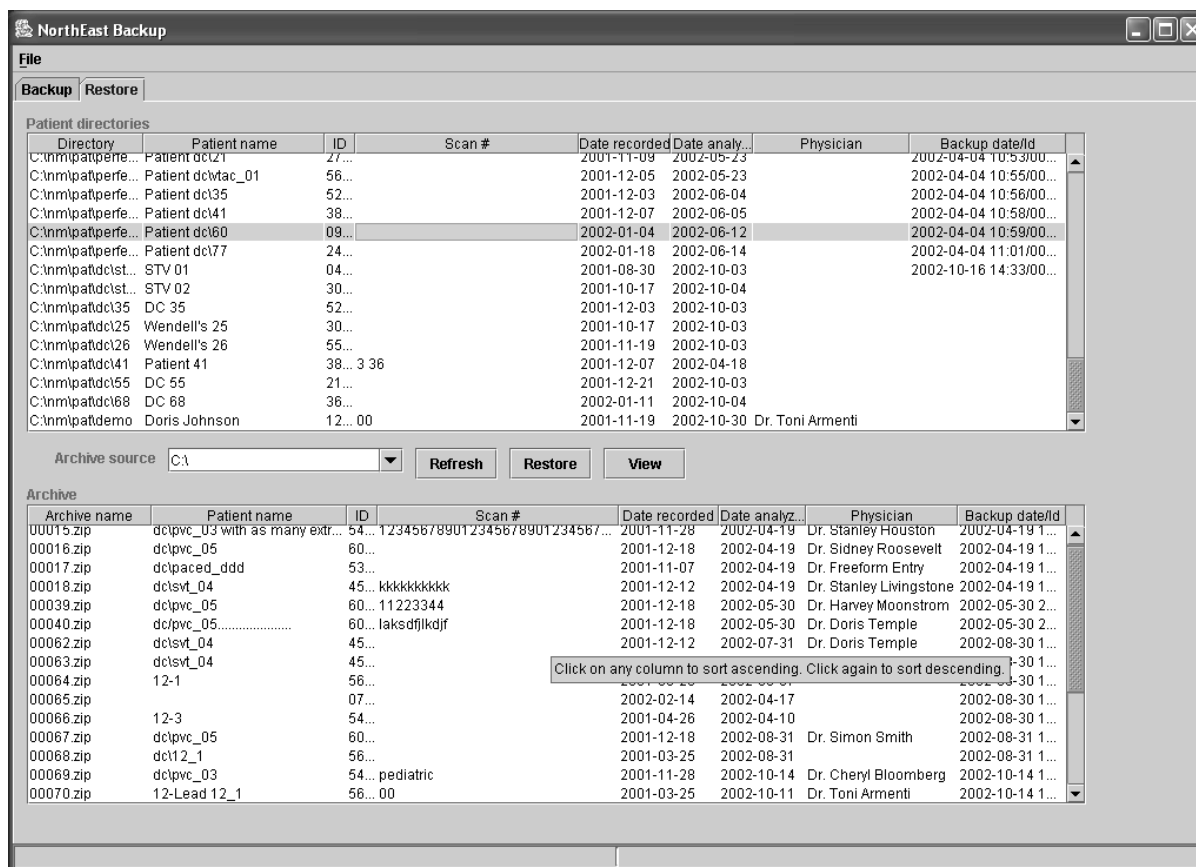
In the Backup window, the Archive Destination directory field indicates what device and directory will store the backup file. The setting defaults to \nm\backup on your hard drive. To save the backed up report elsewhere, select a device from the list associated with the Archive Destination directory field and type in the appropriate directory name before clicking on the Backup button.

See the sections about archiving reports on CD using Roxio Easy CD Creator later in this chapter for details about moving the files in the backup directory to permanent storage.

Retrieving a backed up patient report

To retrieve a patient report that has been backed up, go to Patient > Open, then click on the Backup button. The Backup window opens, with two tabs at the top. Click on the Restore tab to open the Restore window.

In the Archive source field, select the drive on which the patient reports are backed up. Any reports the software finds on that drive will be listed in the bottom portion of the window. In that bottom portion, click on the patient report you want to retrieve; in the top portion, click on the patient slot where you want the retrieved report to go.



Restore tab in Backup window

The patient report in that slot will be over-written, so be sure to select the slot carefully. Then click Restore. When the Confirmation window appears, click Yes to retrieve the backed up report. Click No to close the Confirmation window without retrieving the report.

Click on the X in the red button at the top right of the Backup window to close it.

Note: *You can retrieve only the same type of report you backed up. If you backed up a Full report, all the Holter data is there for you to re-analyze, if necessary. If you backed up a Report, only an electronic version of the printed report is available, and re-analysis is not possible.*

Additional features in the Backup window

The Backup and the Restore tabs of the Backup window also include these buttons, which function as indicated:

Refresh: Redisplays patient report lists, reflecting any changes.

View: Allows you to select a backed up report and view it on-screen without restoring it onto the current Patient List. Once it's displayed, you can also print the report.

Copy to clipboard: Allows you to export a patient's backed up report to a spreadsheet. For details, see the section "Using a spreadsheet to keep track of archived data," later in this chapter.

Using Roxio software to archive records on CD

The Backup program built into the Holter LX software can be used to archive patient reports onto a compact disk using Roxio Easy CD Creator software. During the procedure, the patient files are copied from the system's hard disk, compressed, and saved to CD. There are two requirements: (1) the Roxio software must be installed on your system's hard disk and (2) your system must have CD drive that can write to CD.

As a general rule, each 700-MB CD can hold about 10 to 15 full patient reports (called "Full" in the Backup Settings), including 24 hours of editable ECG, or between 200 and 300 partial records (called "Reports" in the Backup Settings) that include the entire Holter report, but not the full editable ECG.

You have two options for backing up:

- copying a group of zipped patient files at a single session onto a CD, using a format that is more likely to be accessible by any computer system; or
- copying zipped patient files at multiple sessions to a CD that is considered a direct device, using a format that perhaps will not be supported in the future.

Note: *We recommend that the former approach be used when backing up patient reports for permanent archival. That approach is described first in the following documentation.*

Backing up a report on CD - single session

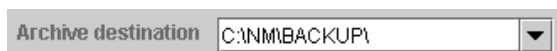
The procedure consists of three steps:

1. using the Holter LX Backup software to compress patient files and save them in a temporary location (this step was already covered in a previous section, but is also included in the following instructions),
2. using Roxio software to copy the compressed files to CD, and
3. deleting the compressed patient files from the temporary location.

Compressing Holter data for backup

To start the backup procedure:

1. Launch the Holter LX software.
2. Select Patient >Open.
3. Click Backup to open the Backup window, which displays the Backup tab.
4. In the Destination field, enter the device and directory in which backed-up files will be stored temporarily. Use c:\nm\backup.



Archive destination field in Backup window

5. In the list of patients, click on the patient report you want to back up; if your patient list is longer than the window display, use the scroll bar to display additional patient reports. To back up multiple sequential patient reports, click on the first report to be

backed up, then drag down to the last one you want backed up.

6. With the appropriate patient(s) selected (that is, highlighted), click Backup again. A small Backup status window opens, displaying the current compression step.



Backup window displayed during compression

7. When compression is complete and the files have been transferred to the \nm\backup directory, the status window closes. You can continue with formatting the CD.

Note: For details about what files get compressed and assigned file names, refer to the “Backing Up Patient Reports” section earlier in this manual.

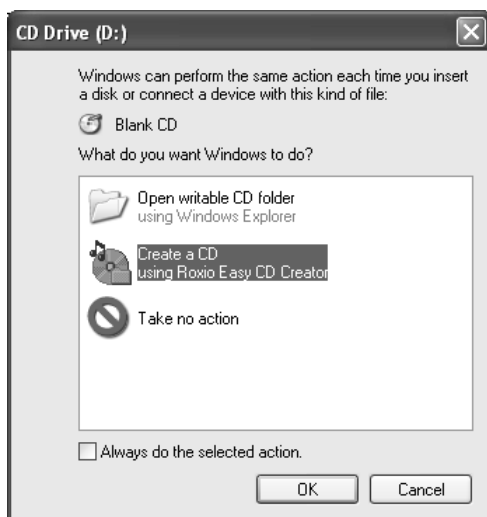
Copying to CD

To copy the zipped files produced by the backup program onto CD:

1. Insert a blank, writable CD-R (not CD-RW) into the drive. Explorer opens a CD Drive window asking how to proceed.

Note: Although it is possible to use a CD-RW for backup, it requires a prolonged formatting period and is more expensive. Because the backup procedure is intended to be permanent storage of patient records, there is no advantage to using CD-RWs.

2. If an Explorer window opens asking how to proceed, select the choice “Create a CD using Roxio Easy CD Creator” to launch the Roxio Easy CD Creator software. If an Explorer
4. The middle menu choice is “data CD project.” Click that. The Data CD Project window opens, as shown below.

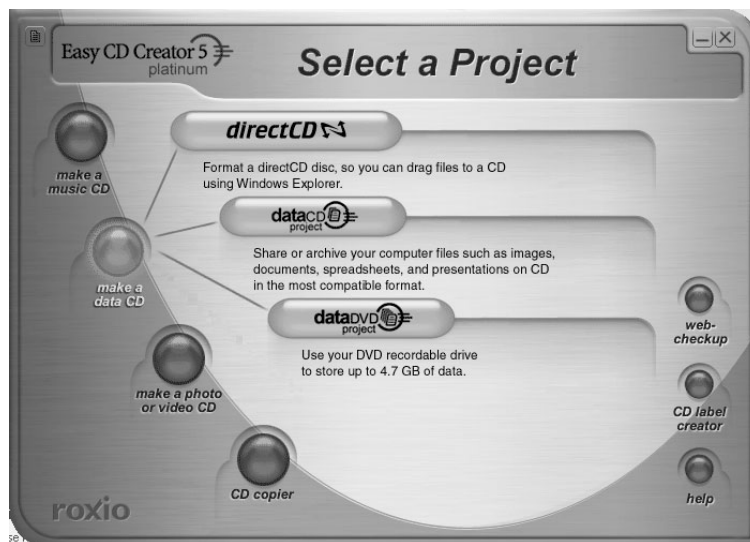


Explorer's CD Drive window

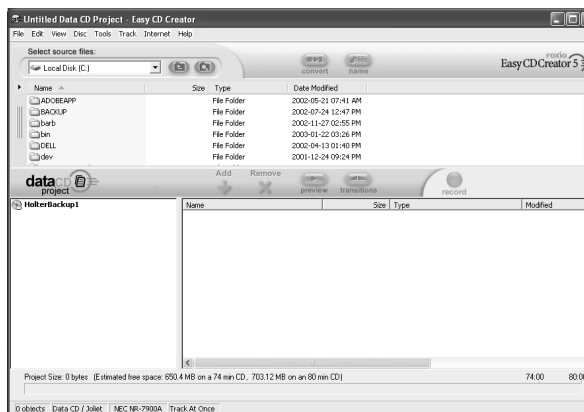
window does not open, launch the Roxio Easy CD Creator from your Start > Programs menu.

3. The Roxio main menu appears.

Place the cursor over the button labeled “make a data CD” so that additional menu choices appear as shown to the right.

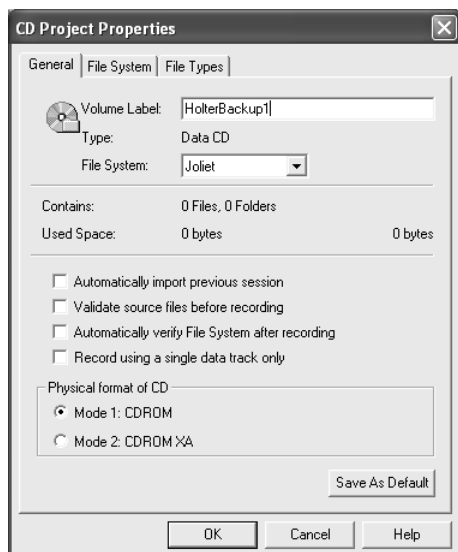


Main menu of Roxio Easy CD Creator



Data CD Project window

5. Select File > CD Project Properties to open the properties window as shown below. Type the label you want for the CD in the Volume Label field.

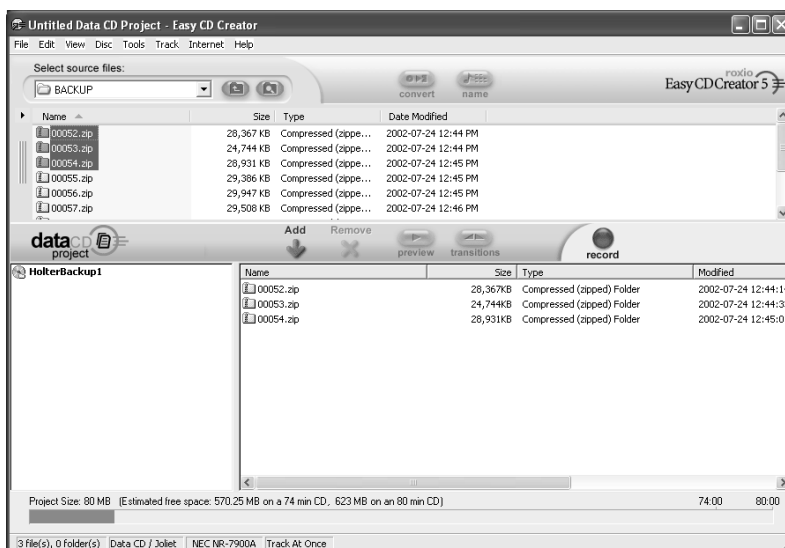


CD Project Properties window

6. Make sure that "Joliet" is listed in the File System field. If it is not, select it from the list of choices.
7. Click the radio button labeled "Mode 1: CDRROM."
8. Press OK to close the window.
9. Within the Data CD Project window, the "Select source files" field should read "Local Disk (C:)" and should list directories/folders below it. One of the directories is named "nm" - for NorthEast Monitoring. Double-click that folder so that

"nm" appears in the Select source files field and additional directories are listed below it. In that list of directories, double-click on "backup" to select it; "backup" appears in the Select source files field, and the compressed files (named *.zip) are listed below that.

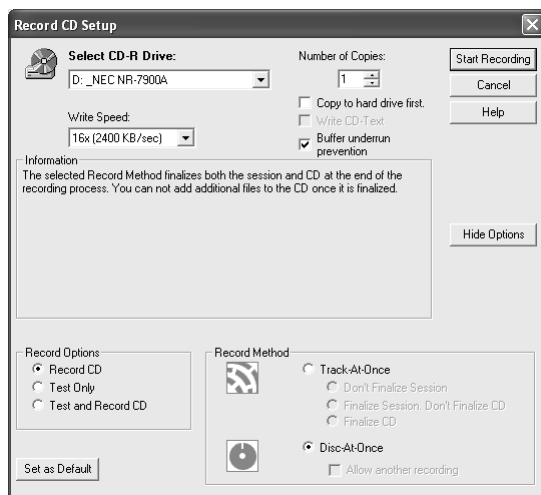
10. From the list, select the patient records to be backed up, which will typically be all the files listed. Click on a file name to select it; to select multiple sequential files, click on the file name, press the Shift key and drag to the last file name. To select all files, hold down the Ctrl key and press A.
11. With the files you want highlighted, click the Add arrow near the center of the window. The selected file names appear below the Add arrow. You can also choose to drag the highlighted file names from the top of the window to the space below the Add arrow. Files can also be



Data CD Project window with selected files in Add list

selected individually and added to the Add list one at a time.

12. When all of the files you want copied to the CD appear in the Add list, press the red record button. The Record CD Setup window opens.

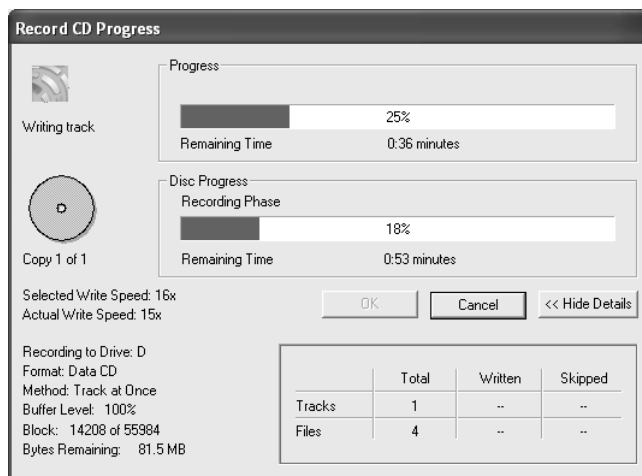


Record CD Setup window

Note: If the record button is dim, you have not yet moved files to the Add list. You must have selected at least one file and moved it to the Add list for the record button to turn red.

13. When the Record CD Setup window opens, if the Options button appears, click it to include the record options at the bottom of the window, as shown in the figure above. If the Hide Options button appears when the Record CD Setup window opens, the options are already displayed.
14. In the Record Options area, "Record CD" should be selected. In the Record Method area, click on "Disc-At-Once." This will allow you to copy files to the CD and then close the session to future additions.

15. Click the Start Recording button.
16. The Record CD Progress window shown below appears as the files are copied to CD.
17. When copying is complete, a query about launching CD Label Creator opens. To Close the current CD session, click Close.
18. In the Record CD Progress window, click OK.
19. If a query window appears asking you whether you should save the project, click Yes.
20. The Explorer window for the CD drive appears with the compressed files listed as "Files Currently on the CD." Close the window.
21. Eject the CD from the drive and label it appropriately, with a unique name that will distinguish this CD from other backup CD.



Record CD Progress window

Note: Do not remove the CD from the drive while it is still being written to. Wait for the spinning sound to stop before removing the CD.

Deleting compressed files

22. To delete the compressed files from their temporary location, go to My Computer and double-click Local Disk.
23. Double-click the nm folder to open it.
24. Double-click the backup folder to open it, displaying the compressed files (*.zip) currently in the folder.
25. To delete the files one-by-one, right-click on each file you have backed up and select Delete. To delete all files, select one of them, then hold down the Ctrl key and press A to select all, then press Delete.

Note: If you do not delete files from the \nm\backup directory, they will accumulate and you will have to keep track of which ones have been copied to CD and which ones have not. Instead, we recommend that you routinely delete all files after copying to CD so that when you are backing up, you know that any files in the \nm\backup directory have not yet been copied to CD.

Backing up a Holter test on “direct” CD

The procedure consists of three steps:

1. properly formatting the CD,
2. using the Holter LX Backup software, and
3. closing the CD session.

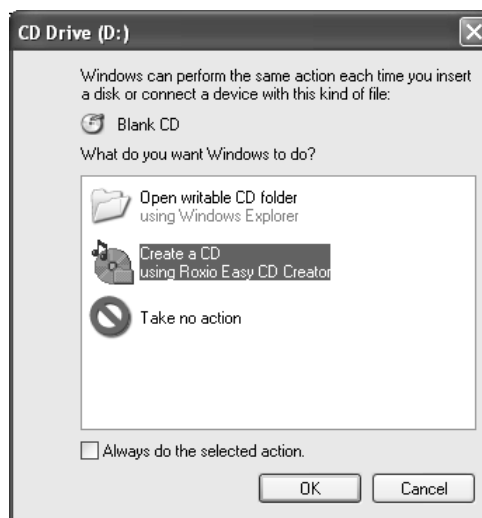
Formatting the CD

To format the CD to accept the zipped files produced by the backup program:

1. Insert a blank, writable CD-R (not CD-RW) into the drive.

Note: Although it is possible to use a CD-RW for backup, it requires a prolonged formatting period and is more expensive. Because this procedure allows you to periodically copy patient records to the same CD until it is full and because the backup procedure is intended to be permanent storage of patient records, there is no advantage to using CD-RWs.

2. If an Explorer window opens asking how to proceed, select the choice “Create a CD using Roxio Easy CD Creator” to launch the Roxio Easy CD Creator software. If an Explorer



CD Drive window with Roxio selection

window does not open, launch the Roxio Easy CD Creator from your Start > Programs menu.

3. The Roxio main menu appears.
4. Place the cursor over the button labeled “make a data CD” so that additional menu choices appear as shown at right.
5. The top menu choice is “direct CD.” Click that. The Roxio format utility opens.



Roxio format utility

6. Make sure the correct drive name is listed in the select CD field as shown in the figure above. Then click the Format CD button in the center of the display. The Format window opens.



Direct CD Format window

7. Type a label name for the CD (choose a unique name that will dis-



Roxio main menu with “make a data CD” choices

tinguish this CD from other backup CDs) in the field indicated in the Format window. If you have inserted a new blank CD-R, the Quick Format and Full Format selections will be dim; the Quick Format will be done.

Note: If the Quick Format selection is dim and the Full Format selected, and you cannot click the Quick Format radio button on, you probably have a CD-RW in the drive. We recommend that you use a CD-R instead.

8. Click the Start Format button. Several windows open in sequence. When formatting is complete, Explorer opens an empty window for the indicated drive.
9. Close the Explorer window to reveal a CD Ready window; click OK to close that; and then close the Roxio format utility display.
10. Launch the Holter LX software and continue with the steps in the next section.

Using the Holter LX Backup software

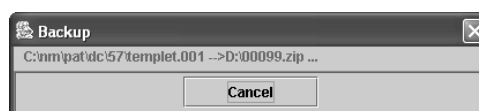
11. After launching the Holter LX program, go to Patient > Open, then click the Backup button.
12. In the Backup window, the Backup tab should be displayed. From the list of patients in the Backup window, click on the patient report you want to back up. To back up multiple sequential patient reports at one time, click on the first one to be backed up, then drag down to the last one you want backed up. Or click on the patient report you want to back up and then press the Shift key and click on additional patients.
13. In the Archive destination field under the patient list, select the appropriate drive name for your system's CD drive. Click on the arrow

at the right of the field to display the drive choices; click on your choice to change the setting.



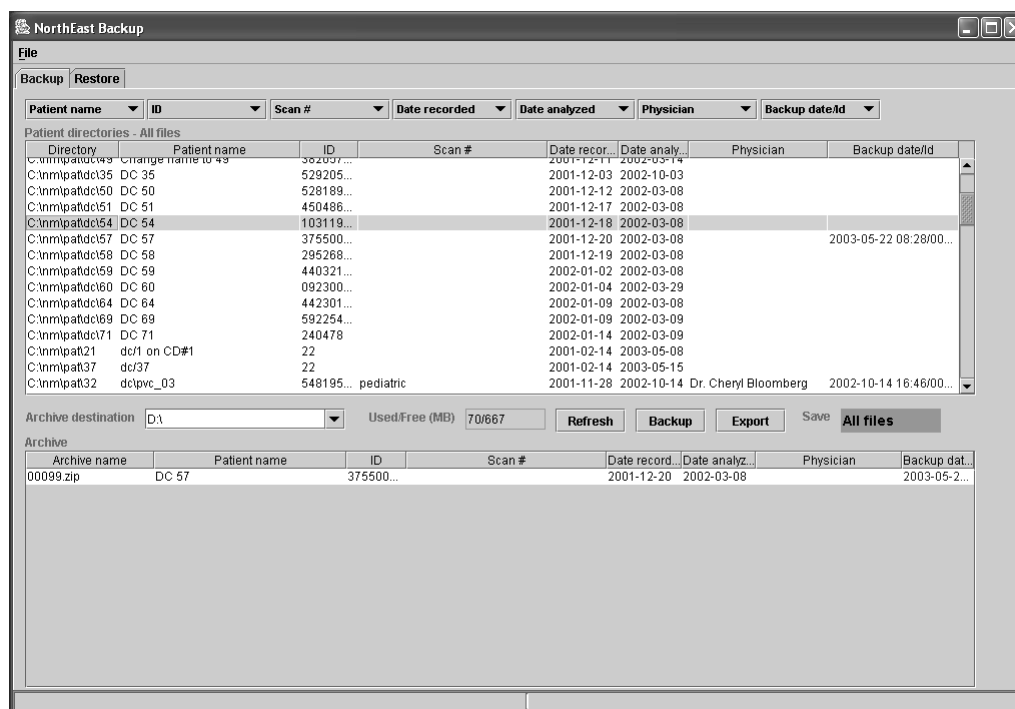
Archive destination field in Backup window

14. With the appropriate patient(s) selected (that is, highlighted), click Backup again. The report for each patient is compressed into a zip file and transferred to the CD.



Backup window displayed during compression

15. When the procedure is complete, the Backup window reappears, with the list of backed up patients in the bottom half of it.



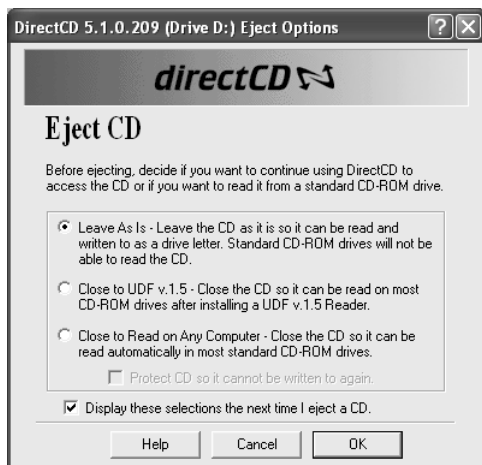
Backup window with Backup tab displayed

16. Click the red close button in the upper right corner to exit the Backup window and return to the Open patient window.
17. To remove the CD from the drive, follow the directions in the next section.

***Note:** Details of what gets saved for each patient report and how to retrieve a patient report from archived files are covered in the early sections of this chapter.*

Closing the CD session

18. Once you have backed up patient files on CD, to remove the CD, you must first indicate how to save the CD. To do so, select the Roxio software so that the format utility is displayed.
19. Click the Eject button in the center of the display. The Eject Options window opens with the following choices:



Eject Options window

- **Leave As Is** - This leaves the CD in a state so that you can continue to add patient reports to it. In this state it is only readable by a system running Roxio Easy CD Creator Software.
 - **Close to UDF v.1.5** - This saves the information on CD, but will not allow additional patients to be added. It can only be read by a system running UDF v.1.5.
 - **Close to Read on Any Computer** - This saves the information on CD, but will not allow additional patients to be added. It can be read on most standard CD-ROM drives, without Roxio software.
20. To save to the CD, but allow additional patients to be added in the future (up to the storage limit of the CD), click “Leave As Is” to select it, then click OK. The CD drive opens and the following window appears.



Ejected CD window

21. Click OK.
22. Remove the CD and label it appropriately.
23. If the Roxio format utility is still displayed, click the close button in the upper right corner to close it.

Adding patient reports to CD

To copy additional patient reports onto a directCD that already contains some:

1. Insert the CD into the drive. If a window opens displaying what is on the CD, close it.
2. Launch the Holter LX software and follow steps 10 through 19 listed above.
3. If the CD is not yet full, you can proceed with steps 20 and 21, and then remove the CD from the drive. If the CD is full, (1) select the “Close to Read on Any Computer” choice in the Eject Options window in step 20 so that the information is permanently archived in a format that is accessible by most CD-ROM drives without Roxio software and (2) click to turn on “Protect CD so it cannot be written to again;” then click OK and remove the CD from the drive.

Keeping track of archived data

Once you have backed up patient reports (either Full reports including all the recorded ECG or Reports including just the information in the printed report) onto CD, you need to keep track of which CD holds which patient reports. You can do this using either (1) the Backup Log in the Holter LX software or (2) a spreadsheet program like Microsoft Works Spreadsheet.

Using the Backup log

To view a list of the patient reports you have backed up using the Holter LX software:

1. Select Patient > Open.
2. Click the Backup button.
3. Select File > Backup log.

The Backup log lists the archived names of the backed up files, then any column headings (variables) you selected in the Backup Settings window.

To add the name you gave to the CD on which reports were backed up:

1. Click on the individual patients you backed up. To select multiple sequential patients, hold down the Shift key as you click.
2. Click the Set volume name button.
3. Type the unique name you gave to the CD holding the backed-up reports. Then click OK.

The Backup log now contains the name of the CD on which the backup file is saved. It appears in the Backup Date/I.D. field.

To print the Backup log, select the rows to be printed, then click the Copy to clipboard button. Using a spreadsheet program, paste the information into a new spreadsheet and print as instructed by the spreadsheet program. For details about using the MicroSoft Works Spreadsheet to track patient data, see

the instructions in the following section.

Using a simple spreadsheet list

The simplest way to use a spreadsheet program is to create a spreadsheet that lists all the patients on a particular CD and print that list to archive with the CD. Alternatively, you can create one large spreadsheet listing all archived patients and the CD label on which they are saved; this spreadsheet can later be used to locate a patient name and then obtain the CD label.

To create a printout listing the patient reports on a particular CD:

1. Launch the Holter LX program.
2. Select Patient > Open.
3. In the Open Patient window, click Backup.
4. In the Backup window, in the bottom half of the window, select the Archive destination where the patient records were stored. If you backed up using the dataCD method described earlier, the Archive destination was c:\nm\backup\. If you used the directCD method, the Archive destination was originally your CD drive (often d:); make sure you have the CD in the drive when you select the drive. The patient records you just backed up will appear in the bottom half of the Backup window.
5. Press the Copy to clipboard button.

6. Launch the Microsoft Works Spreadsheet. An empty spreadsheet opens.
7. Select Edit > Paste. The data selected in the Backup program is entered in the data fields of the spreadsheet.
8. Select File > Save As. Select an appropriate folder/directory in which to save the document and type an appropriate name (for example, the Volume Label you assigned the CD).
9. To print the spreadsheet to keep with the CD or to file, use File > Print.
10. Use File > Exit to close the spreadsheet program.

Creating a spreadsheet listing all archived patient names

If you create a single spreadsheet listing all archived patient names, you can more easily locate the particular CD on which a patient record is archived. To create the spreadsheet:

1. Follow steps 1 through 8 above.
2. Create a new column by clicking in the spreadsheet in the field to the right of "Volume" and selecting Insert > Insert column.
3. Type a label for the column; call it "CD Label."
4. Click on the first field below CD Label and type the label of the CD on which the patients were archived.
5. Drag across the label you have typed to select it and select Edit >

Copy to make a copy of the text.
Paste the copy into each of the CD
Label fields of the other patients
backed up on that CD.

6. Follow steps 9 through 11 above.
7. Whenever you want to add patients to the spreadsheet, launch the Holter Backup program, select the appropriate archive destination and click Copy to clipboard. Then open the spreadsheet file, click on the row below the last used row and select Edit > Paste.
8. To eliminate the extra row of labels at the top of the new list, use Insert > Delete row.
9. Add the appropriate CD label in the CD Label column.
10. Select File > Save, then File > Exit.

Locating a patient record in the spreadsheet

To find a particular patient in the spreadsheet, sort (using Tools > Sort...) by the name or scan number column, locate the match, then refer to the CD Label field to see which backup CD holds that patient record.

10 CONFIGURATIONS

The Configuration program (also called the Configurator) allows you to customize certain aspects of the screen displays, analysis and reports. With careful attention to detail, you can establish report formats that are specific to a physician or automatically change dozens of analysis settings for a particular patient type (e.g., patients with pacemakers). Each separate customized format is called a configuration.

Running the Configuration program

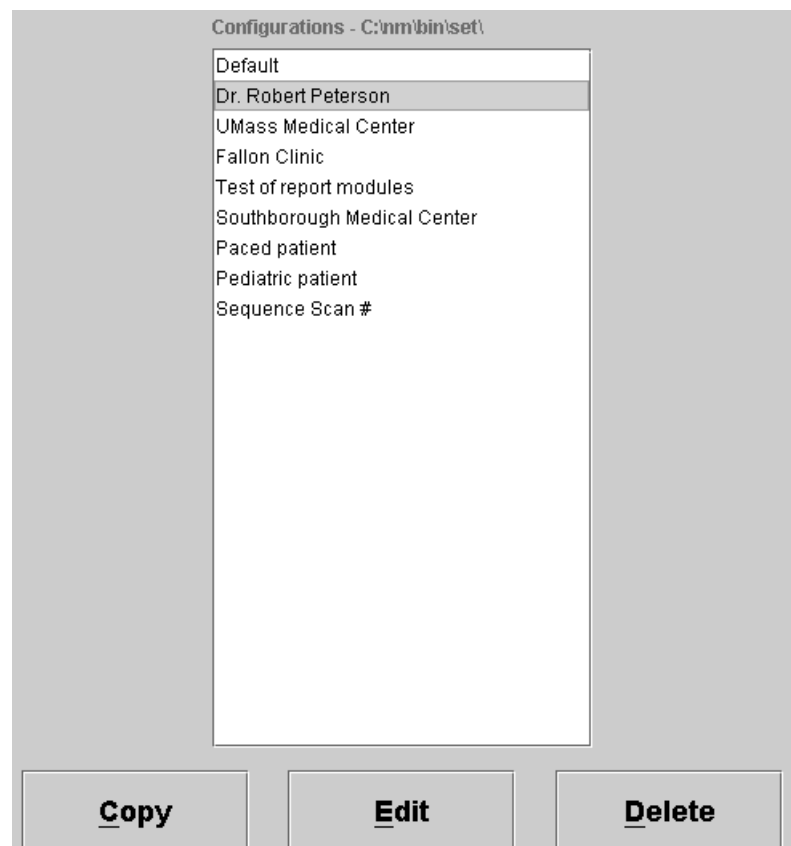
You can access the Configurator either with the Holter LX Enhanced/Enhanced Plus program running or when the Holter program is not running.

Within the Holter program

With the Holter program running, select Patient > Preferences. At the bottom of the Preferences window, click the Configurations button. The main Configurations window opens.

From the Start menu

With the Holter program not running, select Start > Programs. From the Programs menu, select Holter 5. From the Holter 5 menu, select Configure. The main Configurations window opens.



Main Configuration window

Configuration window

The main Configuration window opens with a listing of all current configurations of your software. Each should have a unique name. To make changes, you can either edit an existing configuration or create a new one. You can also delete a configuration if you no longer need it.

To edit an existing configuration, click on the name associated with the configuration you want to change, and then click the Edit button.

To create a new configuration, click on the name associated with a configuration similar to the one you want to create, and then click the Copy button.

To delete a configuration, click on the name associated with the configuration you want to eliminate, and then click the Delete button.

Configuration folders

The window for a specific configuration consists of a pile of folders with tabs. Each folder contains the controls

The screenshot shows a window titled "Paced patient (C:\nm\bin\set\ls000.ini)". It features a series of tabs at the top: Page/Saved Strips/Critical Events/Superimposition/Calibration, Trend/Lorenz Plot, 12 Lead, 12 Lead List, SD360, Research, Rhythm, Scanning Criteria, Spectral Settings, Spectral HRV, and What Strips to Auto Save. Below these are more specific tabs: Main, Colors, Diary, How Often Strips Auto Save, Indication, Label, Medication, Miscellaneous, Oximetry, and Report. The main area contains several input fields with labels: Description (Paced patient), Physician (Dr. Peter Petarski), Interpreting physician, Scan #, Hookup tech (MM), and Analyst (MM). At the bottom, there are four buttons: OK, Cancel, Copy this tab to current patient, and Copy to all configs.

Configuration folders

for a particular window or portion of the Holter LX Enhanced/Enhanced Plus software. Within the folders for a configuration, any entry in any of the fields automatically appears whenever you create a new patient using that configuration.

Note: *The configurations appear as choices in the Type of analysis/report field when you select Patient > New. In addition, they appear when you are initializing a flashcard/SD card.*

To display the fields in a particular folder, click on the tab for that folder.

The folders contain the controls indicated:

- **Main** - This includes fields indicating the name (description) of the configuration, which appears in the list whenever you start a new patient; the physician's and interpreting physician's names associated with the configuration; the scan number; hookup technician; and analyst.

Note: *When you create a new configuration by using the Copy button, the Description field in the Main folder reads ***New***. Be sure to type a new name for the configuration in the Description field to differentiate it from others you create.*

Note: *The Main folder contains the Scan # field which controls the auto-sequencing of the Scan number in the Patient window. To have the system automatically increment the scan*

number for each patient, enter \$seq in the Scan # field; to include the date and/or time-of-day in the Scan # field, enter \$date or \$time, respectively. Use whatever order you want the scan number to follow. Also, be sure to turn on the "Assign date and time to Scan #" feature in the Preferences window.

- **Colors** - This controls the colors used throughout the system. Because the Holter analysis is color-coded, changes should be made very carefully here.
- **Diary** - Different diary entries can be added, and diary entries can be replaced with other text or deleted singly or all together. The diary entries appear in the drop-down list of choices in the Symptom field in Patient Information > Diary.
- **How Often Strips Auto Save** - This controls the settings that come up automatically in this window in Patient Information > Settings > How Often Strips Auto Save.
- **Indication** - Different indications can be added, and current indications can be replaced with other text or deleted. The Indication choices appear in the Indication area of the Patient Information window.
- **Label** - Strip labels can be changed from their present text to whatever text you use to replace them. Strip labels appear in the Saved Strips window, the Keep window, and in the final report.

Note: *Changes in labels must be made carefully because the meaning of the label **MUST NOT** change. For example, when the system calls a beat ventricular, it uses the **VPB** label when saving strips for the report; you can change the text to read **VE** instead, but not **SVPB** or **BBB**, or your report will be incorrect.*

- **Medication** - Different medications can be added, and current medications can be replaced with other text or deleted. The Medication choices appear in the Medication area of the Patient Information window.
- **Miscellaneous** - This controls the beat-by-beat annotation, the ST segment analysis location in the Preferences window, and some advanced file naming fields.
- **Oximetry** - This controls the settings that come up automatically in the window accessed by selecting Settings > Oximetry.
- **Report** - This allows you to have a configuration with a different report heading, a different selection of report modules, along with different settings for the Strip annotation, Full disclosure, Report summary, and Saved strips fields in the Reports window. You can also change the registration name and address.
- **Research** (optional) - This controls the automatic settings that appear in the Research window, if it is available to you. Open the window by selecting Settings > Research. This tab does not appear if you do not have the Research option.
- **Rhythm** - Different rhythm types can be added, and rhythm types can be replaced with other text or deleted. Rhythm types appear in the Comment field in Tables > Edit. They do not appear in the printed report.
- **Scanning Criteria** - This controls the automatic settings that appear in the Scanning Criteria window. The window is accessible from the Patient Information window by clicking Settings > Scanning Criteria or from the main Holter menu under Settings > Scanning Criteria.
- **Spectral Settings** - This controls the automatic settings that are used for spectral analysis.
- **Spectral HRV** - This controls the colors used in the heart rate variability plots in the HRV menu.
- **What Strips to Auto Save** - This controls the settings that come up automatically in this window in Patient Information > Settings > What Strips to Auto Save.
- **Page/Selected Strips/Critical Events/Superimposition/Calibration** - This controls the appearance of some of the Review windows, including some colors, the settings in some fields, and whether the window initially appears in Expanded mode.
- **Trend/Lorenz Plot** - This controls the colors in these plots and the Type that is initially displayed.
- **12 Lead** - This includes controls for 12-lead strips display, including colors.

- **12 Lead List** - This shows the text that appears in the list of choices when you add a 12-lead strip to the printed report. To see the list in 12 Lead Strips, click on Add/Del to open the Add/Del window, click on the Description text field, and then click on arrow at the right end of the field.

Saving a configuration

For each configuration you create or edit, make changes in as many folders as you need to. When all folders reflect what you want to associate with that configuration, click the OK button at the bottom of the window. Your new configuration will be saved and the window closed; the main Configurator window then appears.

Canceling a configuration

To exit without saving the new configuration, click Cancel. The window closes and the main Configurator window appears.

To create or edit another configuration, use the Copy or Edit button again.

Copying to a current patient

The Copy this tab to current patient button allows you to make changes to the displayed fields within the record of the current patient. If this button is dim, those changes cannot be made because they might cause inconsistencies.

Copying changes to all configurations

To copy any changes associated with a tab/folder to all other configurations, instead of having to make them to every configuration separately, use the Copy to all configs button. That applies the settings of the displayed fields to all other configurations.

Exiting from the Configuration program

To exit from the Configuration program, click on the red Close button in the upper right corner of the window.

Using a configuration

The configurations created or edited using the Configurator appear when you start a new Holter test and when you initialize an SD card. When you select Patient > New to open the Patient Information window for a new Holter test, a list of the Configuration descriptions appears in the Type of analysis/report field; select your choice from that list. When you initialize an SD card before a recording, the list of Configurations appears in the SD360 settings field of the Setup SD360 settings window; select your choice from that list.

For example, a configuration called “DDD Paced” can be set up so that (1) the pacemaker settings in the Scanning Criteria window are appropriate for a patient with a DDD pacemaker and (2)

the Reports window opens with the pacemaker modules already checked. When you start the Holter test for a patient with a DDD pacemaker, you could select Patient > New, then select the DDD Paced configuration. That would mean that you would not have to (1) go into the Scanning Criteria window to turn the pacemaker mode on and set each pacemaker setting appropriately and (2) check off each report module you want in the report.

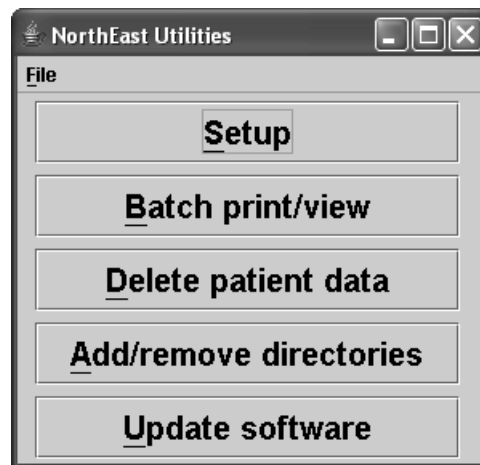
Of course, if you use an inappropriate configuration for a patient, after analysis, you can always go to the appropriate Settings windows and make necessary changes; the system will automatically update or re-analyze as needed.

11 UTILITIES

The Holter LX Utilities allow you additional control over some of the technical aspects of your software, including the restructuring of your system to hold more patient Holter tests within the program, updating your software, and accessing additional directories on your hard drive.

Running the Utilities program

You should access the Utilities when the Holter LX Enhanced/Enhanced Plus program is not running. To run Utilities, select Start > Programs > Holter 5 > Utilities. The Utilities window appears. The buttons in the Utilities window allow you access to the Setup window you saw during the software installation process, to add and remove patient directories and patient data, and to update the LX Enhanced/Enhanced Plus software to the latest release.



Utilities window

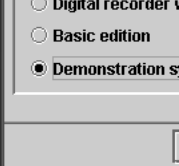
Click the buttons to open the following windows:

Setup window

The Setup window contains information specific to your facility and Holter LX software. This includes the names of both your facility and the primary user of your Holter software, along with five lines for the name and address that appear in the Reports window when you go to print a Holter report. To change the entries in those fields, select the characters to be replaced and type the text you want in the appropriate locations.

To change the language used throughout the Holter LX software, make your selection from the drop-down menu associated with the Language field.

To change the number of patient reports stored on the hard disk of your computer, you can either enter a different



Setup window

number in the Number of patients field in this window or use the Add/remove directories accessible from the Utilities menu. If you choose to change the number here in the Setup window, all patient directory slots will be overwritten with empty new patient slots, so be sure any patients whose reports will be overwritten are already backed up before you proceed.

The Registration number is assigned specifically to your system based on the software key (a.k.a. dongle) attached to either the parallel port or the USB port of your computer. It controls the features of your Holter LX system. You should not

Setup

Company NorthEast Monitoring

User name 12

Language English

Report heading

NorthEast Monitoring Inc.

Two Clock Tower, Suite 360

Maynard MA

Number of patients 40

Registration

Options

☐ Digital recorder with a software key

☐ Basic edition

☒ **Demonstration system**

OK **Cancel**

Setup window

change this number unless you upgrade your software to include additional features. This field works in conjunction with the “Digital recorder with a software key” radio button in the Options area; that must be selected to enable the registration number.

The radio buttons in the Options area control whether the system can read new information off of a compact flashcard/SD card from a DR180+ or

SD360 recorder and, if it can, what features are available. These should not be changed. If you have LX Enhanced/Enhanced Plus software, make sure you always select the “Digital recorder with a software key” in the Options area, or you will lose many features of the software.

Directory name	Pa...	ID	Scan #	Analyzed	Backup
C:\nm\pat133	dc...	5362...		2002-10-16 11:48	2003-09-02 10:30
C:\nm\pat134	ddd	5362...		2002-10-16 12:16	2003-09-02 10:31
C:\nm\pat135	dc...	6082...		2002-10-16 13:51	2003-09-02 10:31
C:\nm\pat136	dc...	4516...	451515515151515511515...	2002-10-16 13:59	2003-09-02 10:32
C:\nm\pat137	dc...	22		2003-05-15 16:26	2003-09-02 10:32
C:\nm\pat138	La...	2720...		2003-09-18 10:00	2003-09-02 10:33
C:\nm\pat139	te...	2720...		2003-09-11 08:08	2003-09-10 10:24
C:\nm\pat140	Fr...	123	03--1551	2003-07-02 09:31	2003-09-02 10:33
C:\nm\pat141	no...	2720...		2003-09-01 11:14	2003-09-02 10:34
C:\nm\pat146	Mi...			2003-11-20 19:56	
C:\nm\pat147	00...	5693...		2003-10-08 12:10	
C:\nm\pat148	Kl...	0626...	162	2003-09-05 12:44	
C:\nm\pat149	Mc...	4141...		2003-10-14 09:24	
C:\nm\patdcl01	do...	22	123456	2003-08-20 11:41	2003-09-02 10:35
C:\nm\patdcl02	do...	5477...		2003-05-09 08:28	2003-09-16 13:05

Batch print/view window

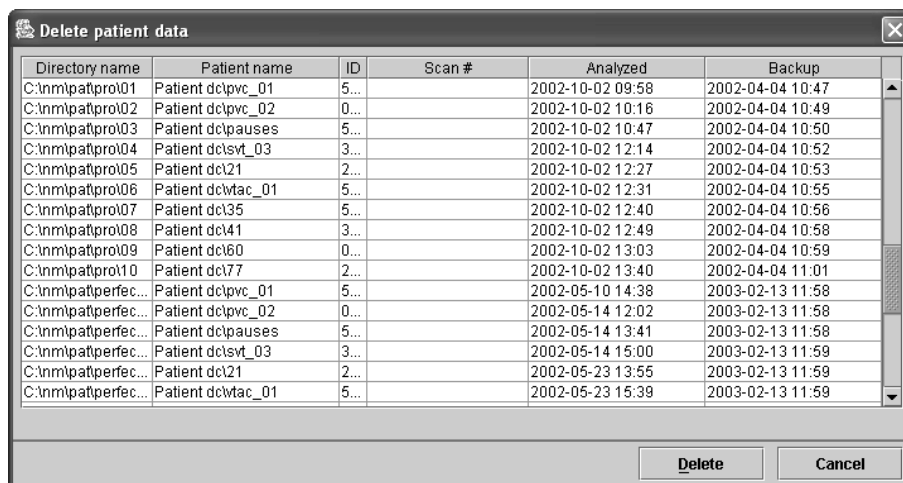
Batch print/ view

Use this utility to list all the patient reports currently on your computer's hard disk and then choose to either print the report or review it on-screen. To select a particular patient report, click on the appropriate line to highlight it. To review the patient report on-screen, click View. To print the report, click Print. To exit from the window, click Cancel.

Delete patient data

This window displays a listing of the patient records currently included in the Holter LX software. To eliminate patients from the listing, select the one(s) to be deleted and click the Delete button. To close the window without deleting any patient records, click Cancel.

Be sure that you have performed any required backing up of patient records before you delete them here.



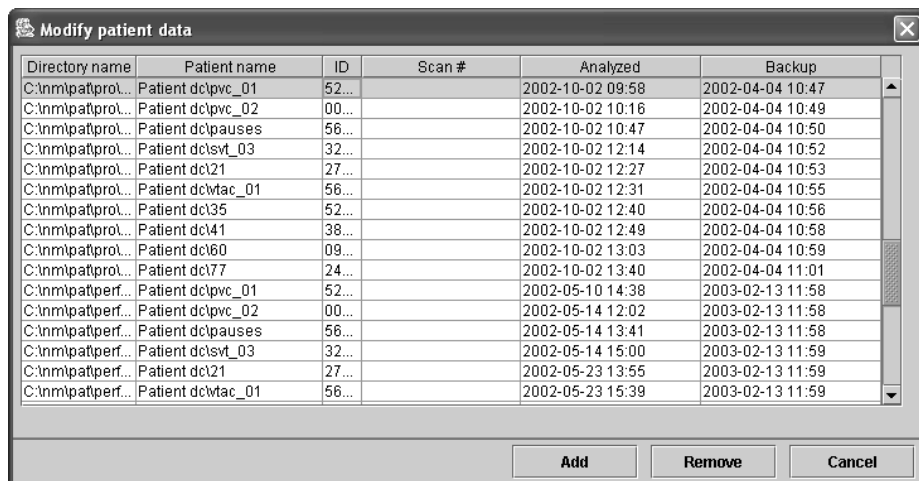
The 'Delete patient data' window displays a table of patient records. The table has six columns: Directory name, Patient name, ID, Scan #, Analyzed, and Backup. The records are listed in a scrollable area. At the bottom right, there are 'Delete' and 'Cancel' buttons.

Directory name	Patient name	ID	Scan #	Analyzed	Backup
C:\nm\pat\prol01	Patient dclpvc_01	5...		2002-10-02 09:58	2002-04-04 10:47
C:\nm\pat\prol02	Patient dclpvc_02	0...		2002-10-02 10:16	2002-04-04 10:49
C:\nm\pat\prol03	Patient dclpauses	5...		2002-10-02 10:47	2002-04-04 10:50
C:\nm\pat\prol04	Patient dclsvt_03	3...		2002-10-02 12:14	2002-04-04 10:52
C:\nm\pat\prol05	Patient dcl21	2...		2002-10-02 12:27	2002-04-04 10:53
C:\nm\pat\prol06	Patient dclvtac_01	5...		2002-10-02 12:31	2002-04-04 10:55
C:\nm\pat\prol07	Patient dcl35	5...		2002-10-02 12:40	2002-04-04 10:56
C:\nm\pat\prol08	Patient dcl41	3...		2002-10-02 12:49	2002-04-04 10:58
C:\nm\pat\prol09	Patient dcl60	0...		2002-10-02 13:03	2002-04-04 10:59
C:\nm\pat\prol10	Patient dcl77	2...		2002-10-02 13:40	2002-04-04 11:01
C:\nm\pat\perfec...	Patient dclpvc_01	5...		2002-05-10 14:38	2003-02-13 11:58
C:\nm\pat\perfec...	Patient dclpvc_02	0...		2002-05-14 12:02	2003-02-13 11:58
C:\nm\pat\perfec...	Patient dclpauses	5...		2002-05-14 13:41	2003-02-13 11:58
C:\nm\pat\perfec...	Patient dclsvt_03	3...		2002-05-14 15:00	2003-02-13 11:59
C:\nm\pat\perfec...	Patient dcl21	2...		2002-05-23 13:55	2003-02-13 11:59
C:\nm\pat\perfec...	Patient dclvtac_01	5...		2002-05-23 15:39	2003-02-13 11:59

Delete patient data window

Add/remove patient directories

This button opens the Modify patient data window that allows you to add a specific directory to the list of patients accessible through the LX software without creating the slot as an empty new patient, or to remove a specific directory from the list of patients without actually deleting the patient from the hard drive. It allows you to access additional patient records that were not



The 'Modify patient data' window displays a table of patient records, similar to the 'Delete patient data' window. It has the same columns: Directory name, Patient name, ID, Scan #, Analyzed, and Backup. The records are listed in a scrollable area. At the bottom right, there are 'Add', 'Remove', and 'Cancel' buttons.

Directory name	Patient name	ID	Scan #	Analyzed	Backup
C:\nm\pat\prol...	Patient dclpvc_01	52...		2002-10-02 09:58	2002-04-04 10:47
C:\nm\pat\prol...	Patient dclpvc_02	00...		2002-10-02 10:16	2002-04-04 10:49
C:\nm\pat\prol...	Patient dclpauses	56...		2002-10-02 10:47	2002-04-04 10:50
C:\nm\pat\prol...	Patient dclsvt_03	32...		2002-10-02 12:14	2002-04-04 10:52
C:\nm\pat\prol...	Patient dcl21	27...		2002-10-02 12:27	2002-04-04 10:53
C:\nm\pat\prol...	Patient dclvtac_01	56...		2002-10-02 12:31	2002-04-04 10:55
C:\nm\pat\prol...	Patient dcl35	52...		2002-10-02 12:40	2002-04-04 10:56
C:\nm\pat\prol...	Patient dcl41	38...		2002-10-02 12:49	2002-04-04 10:58
C:\nm\pat\prol...	Patient dcl60	09...		2002-10-02 13:03	2002-04-04 10:59
C:\nm\pat\prol...	Patient dcl77	24...		2002-10-02 13:40	2002-04-04 11:01
C:\nm\pat\perf...	Patient dclpvc_01	52...		2002-05-10 14:38	2003-02-13 11:58
C:\nm\pat\perf...	Patient dclpvc_02	00...		2002-05-14 12:02	2003-02-13 11:58
C:\nm\pat\perf...	Patient dclpauses	56...		2002-05-14 13:41	2003-02-13 11:58
C:\nm\pat\perf...	Patient dclsvt_03	32...		2002-05-14 15:00	2003-02-13 11:59
C:\nm\pat\perf...	Patient dcl21	27...		2002-05-23 13:55	2003-02-13 11:59
C:\nm\pat\perf...	Patient dclvtac_01	56...		2002-05-23 15:39	2003-02-13 11:59

Modify patient data window

previously accessible and allows you to ignore other records.

Click the Add/remove button to open the Modify patient data window; it displays all the patient directories currently on your hard drive. To allow access to additional patient record(s), select the patient record(s) to be added, then click the Add button. To delete patient record(s), select the patient record(s) to be deleted, then click the Delete button.

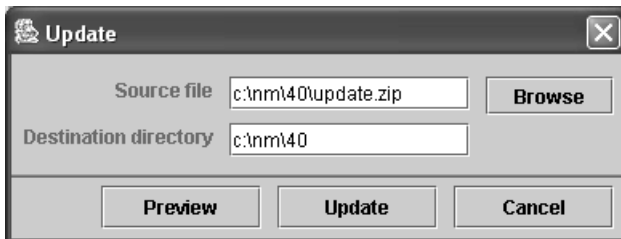
To view information about the update file without installing it, click Preview.

To install the update file specified in the Source file field into the Destination directory, click Update and follow the instructions.

To exit the Update window without installing new software, click Cancel.

Update software

To update your LX software to a newer version, click the Update button to open the Update window. The Source file should contain the directory and file name of the NorthEast Monitoring



Update software window

software update you received. If the Source file is not correct, use the browse button to access other folders to locate the file, or type the correct complete file name including all directories.

To run the NorthEast Monitoring LX software as designed, the destination directory should read "C:\nm\bin". If it does not, type that now.

APPENDIX A

Calculation of Heart Rate

Types of heart rates

A variety of heart rate calculations are made by NorthEast Monitoring Holter LX software. They include:

- Current heart rate
- Minute-by-minute heart rate
- Beat-by-beat heart rate
- Mean heart rate in intervals
- Mean heart rate for Holtered period
- Second heart rate
- Heart rate strips

Current heart rate

This is a complex function that takes the current beat and the beats preceding it into account. This weighted average follows these rules:

1. If the differences between the adjacent beats of the preceding four RR intervals are no more than 12 percent of the average RR interval for the previous beat and the beats are all normal, then the new average RR interval is the simple average of the previous four RR intervals.
2. If the previous four RR intervals were NOT bigeminy, VTAC or SVT AND the current RR interval is within 25 percent of the previous average AND the previous two beats were not ventricular AND the previous 10 beats were not supraventricular, then the new average RR interval is 1/8 of the current RR interval plus 7/8 of the previous average.
3. If the previous four RR intervals were NOT bigeminy, VTAC or SVT AND the current RR interval is not within 25 percent of the previous average OR any of the previous two beats were ventricular OR any of the previous 10

beats were supraventricular, then the new average is $1/32$ of the current RR interval plus $31/32$ of the previous average.

4. If the previous four RR intervals were bigeminy, VTAC or SVT, then the average RR interval is changed by 0.000087 seconds. It is increased if the current interval is longer than the previous interval, otherwise it is decreased.

Once the current average RR interval is determined, the current heart rate is calculated as 60 divided by the current average RR interval, that is, $\text{current HR} = 60/(\text{current RR interval})$.

The current heart rate is used as the heart rate that appears in the heart rate data field for any displayed strip. This includes the heart rate associated with any strip in the Selected Strips window and in the printed report.

The current heart rate is also used to detect tachycardia and bradycardia. The onset of either is determined to be when the current heart rate reaches the tachycardia or bradycardia settings in the Scanning Criteria window.

The low and high heart rates reported in the Tables window and in the tables of the printed report refer to the lowest and highest current heart rate calculated during the interval.

Minute-by-minute heart rate

The heart rate plotted in the Trends window is a minute-by-minute heart rate. It is calculated as 60 times the number of beats processed in the minute divided by the sum of all RR intervals of beats processed in the minute (in seconds).

Beat-by-beat heart rate

The heart rate associated with each beat in expanded displays whenever the Annotation field in the Preferences window is set to Heart Rate is the beat-by-beat heart rate. It is calculated based on the RR interval following the labeled beat. Beat-by-beat heart rate equals 60 divided by RR interval, that is, $\text{HR} = 60/(\text{RR})$.

Mean heart rate in intervals

In the tables (in Tables window and printed report), the mean heart rate within each interval is calculated by dividing the number of beats in that interval by the amount of time processed within the interval.

Mean heart rate for Holtered period

In the Report Summary (in the Report Summary window and printed report), the mean heart rate during the Holter test is the number of beats counted divided by the amount of time processed.

Second heart rate

The second heart rate is the heart rate associated with a run of VTAC or SVT. It is calculated as 120 divided by the sum of the current RR interval and the previous RR interval. The second heart rate appears in strips with VTAC or SVT in Selected Strips, the printed report, and the strip list, labeled HR2.

The second heart rate is used to determine where in the ventricular and supraventricular run tables a run of VTAC or SVT appears. The heart rate separating fast from slow runs is determined by the VTAC and SVT settings in Scanning Criteria, but the rate of each event is considered to be the second heart rate.

The second heart rate is also used to determine which run is identified as the fastest run of VTAC and SVT.

Heart rate strips

In the Critical Events window, there is a choice in the Type field called "HR strips." This displays all ECG from the Holter test divided into 7.5-second strips. Each strip includes a time-of-day and a Strip HR. That Strip heart rate is the total number of RR intervals (including partial ones, but excluding artifact) within the strip divided by the sum of the RR intervals.

Defining dead-time and RonTs

Dead-time is the amount of time (in seconds) after a detected QRS complex during which the software will not look for another QRS complex. Generally, this helps to prevent the misidentification of tall T-waves as QRS complexes.

The operator can add more time to the tail end of the dead-time using the Extra dead-time setting in the Scanning Criteria window. An increase in the Extra dead-time should be done judiciously so that very early VPBs do not fall within it.

Because the recovery time (i.e., the width of the T-wave) varies with heart rate, the dead-time built into the software adjusts based on the current heart rate. At higher rates, the dead-time decreases, and at lower rates, the dead-time increases.

Likewise, the definition of an R on T, which is a VPB falling on the T-wave of the preceding beat, varies with heart rate. Since the software does not identify T-waves, it cannot determine whether a VPB is actually falling on the T-wave of the preceding beat. But the software can calculate where the T-wave for a beat should be and then alert the operator regarding any VPBs that fall within that hypothetical area.

The heart rate determines the dead-time and R on T period definitions as shown in the following table:

TABLE 1. How heart rate determines dead-time and R on T

Heart rate	Dead-time	R on T
50	0.43500	0.440
55	0.38727	0.418
60	0.34750	0.400
65	0.31384	0.384
70	0.28500	0.371
75	0.26000	0.360
80	0.23812	0.350
85	0.22000	0.341
90	0.22000	0.333
95	0.22000	0.326
100	0.22000	0.320
105	0.22000	0.314
110	0.22000	0.309
115	0.22000	0.304
120	0.22000	0.300
125	0.22000	0.296
130	0.22000	0.292
135	0.22000	0.288
140	0.21428	0.285
145	0.20689	0.282
150	0.20000	0.280
155	0.19354	0.270
160	0.18750	0.265
165	0.18181	0.261
170	0.17647	0.257
175	0.17142	0.253

TABLE 1. How heart rate determines dead-time and R on T

Heart rate	Dead-time	R on T
30	0.50000	0.600
35	0.50000	0.542
40	0.50000	0.500
45	0.50000	0.466

APPENDIX B

Using MagicVORTEX

To use NorthEast Monitoring software to send a patient's Holter data to another site for analysis, you must be a MagicVortex customer. To sign up for MagicVortex, visit their web site at www.MagicVortex.com and select Sign up from the menu on the home page. Once you are a MagicVortex customer, you can follow these instructions both (1) to send out the patient data to a receiving site that has agreed to analyze it and (2) to receive a completed report back.

Sending patient data

1. From the Start menu, select Programs > Holter 5 > Remote Setup to open the Patient menu item in the remote reporting software.
2. Select Patient > New to open a patient slot for the patient to be sent. If no empty slot is available, the Open Patient window

The screenshot shows a 'Patient Information' dialog box. It has a title bar with a close button. The main area is divided into two columns. The left column contains text labels and input fields: 'Patient name' (text box), 'Sex' (radio buttons for M and F), 'D.O.B.' (text box with 'YYYY-MM-DD' and a 'Years' dropdown), 'I.D.' (text box), 'Scan #' (text box), 'Hookup tech/analyst' (text box), 'Physician' (dropdown), 'Interpreting physician' (dropdown), 'Date recorded' (text box with 'YYYY-MM-DD' and a time dropdown set to '08:00am'), and 'Recorder #' (text box). The right column contains 'Indication' (three stacked dropdown menus), 'Medication' (three stacked dropdown menus), and a 'Copy flashcard' button. At the bottom, there are five buttons: 'Remote', 'MagicVortex', 'Settings', 'OK', and 'Cancel'.

Patient Information window in Remote Setup

opens and you must delete one of the patients on the list; then close the Open Patient window and select New again.

3. When the New Patient window opens, select an appropriate Type of analysis/report, then click OK. The Patient Information window opens.
4. Insert the compact flashcard from the recorder into the compact flashcard reader.
5. Click the Copy flashcard button in the Patient window. This copies the Holter data from the flashcard onto your computer's hard drive. Some of that data appears in the Patient window; verify that the data from the flashcard is for the correct patient.
6. Enter as much additional patient information as you want included in the final Holter report, including any written diary entries, indications and medications. See Chapter 2: Patient Information, for details about entering patient information.
7. When data entry is complete, click the MagicVortex button in the Patient Information window. This opens the MagicVortex Setup win-

dow. The Enable MagicVORTEX field should have a check mark. The MagicVortex icon on your desktop should contain a blue center indicating that you are currently connected to the MagicVortex.

Note: *If the center of the MagicVortex icon is gray, you are not currently connected to MagicVortex via the Internet and you will not be able to send patient data until the connection is established.*

8. The FTP directory field should read c:\nm\ftp; if it does not, click on that field and type that now.
9. Click on the Destination email field and type the e-mail address where you are sending the Holter data for analysis.
10. Leaving the Options field blank, click on the Location field. This entry will be used to rename the patient files you send so that there is a unique filename at the receiving site. If you have been assigned a location name by the receiving site, type that. If not, type something to identify your location.

MagicVORTEX Setup window

11. Click on the Initials field. Type your initials.
12. When you have completed the fields, click Send. The two files for this patient will be sent to the receiving site. To exit without sending the data now, but saving your entries, click OK. To exit without sending or saving, click Cancel.

Receiving a patient report

To receive a Holter report via MagicVortex, you do not have to be a MagicVortex customer. If you are a MagicVortex customer, the report returned will be automatically downloaded to your computer when the analysis site sends it; if you are not, you must retrieve the Holter report via e-mail.

As a MagicVortex customer

After the analysis site has sent you a Holter report via MagicVortex, the report automatically downloads to your computer. To retrieve the report, open the MagicVortex window (using the icon that looks like the eye of a storm) and it displays the file and its status. Once the download is complete, the status reads “Ready to save.” To save the file, select File > Save from the toolbar, and use the Browser to indicate what folder you’d like to save the report in and what filename to use; then click Save.

To print the report, open the file in the folder where you saved it, and use File > Print to print the report.

Without being a MagicVortex customer

After the analysis site has sent you a Holter report via MagicVortex, you will receive a notice via e-mail that there is a file for you. The e-mail notice will include a link to the site. To retrieve the report:

1. Click on the link and you will be connected to the MagicVortex site, which will request that you log in.

2. Enter the password for your e-mail address and click the Login button. MagicVortex displays your account folder, which contains information about the file that was sent to you, including its name at the top.
3. To retrieve the file, click the Download File button. The File Download window opens.
4. In the File Download window, indicate what you would like to do with the file. We recommend that you Save it using the Save button and using the Browser to indicate the folder where you’d like it saved. The report is now downloaded to your computer.
5. When the download is complete, you can choose to immediately print the report by selecting Open to display the report, and then using File > Print. The Holter report prints, and you have a saved electronic copy of it on your computer in the folder you indicated in Step 4.

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