

GE Healthcare

CardioDay® V2.5

Holter ECG Analysis Software Operator Manual

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CardioDay® V2.5 Holter ECG Analysis Software
English
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Publication Information

The information in this manual applies only to CardioDay® V2.5 Holter ECG Analysis Software. It does not apply to earlier versions. Due to continuing product innovation, specifications in this manual are subject to change without notice.

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Revision History

The document part number and revision appear at the bottom of each page. The revision identifies the document's update level. The revision history of this document is summarized in the following table.

Revision	Publication Date	Description
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E	2019-07-15	New feature: "Site and location filter" Integrated PDF printer MUSE Diagnosis setting New print variables New setting for ECG background grid on the computer screen New setting for order of strips in final report New setting for ECG background grid of strips in final report

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Contents

1	Introduction.....	11
	Intended User	13
	Intended Use	13
	Contraindications.....	14
	Prescription Device Statement.....	14
	Regulatory and Safety Information.....	14
	Safety Conventions	14
	Safety Hazards	15
	Supply and Accessory Information	17
	Manufacturer Responsibility	17
	Product and Package Information	18
	Service Information	20
	Service Requirements	20
	Additional Assistance	20
	Manual Information	20
	Manual Purpose.....	20
	Document Conventions.....	21
	Related Documents.....	22
2	The optimal path for Holter / Ambulatory ECG evaluation	23
	Part I –	
	Downloading and evaluating Holter ECG recordings	
3	Downloading ECG data	27
	Recorder memory card types.....	27
	Program start, User login.....	28
	Start window options	29
	Selecting the recording slot for the patient's ECG recording	30
	Download recording	30
	Sorting the list of patient names	31
	Entering patient data	32
	Signal evaluation and setting of Analysis parameters before downloading the ECG data.....	34
	Signal evaluation during pre-analysis	35
	Overview and Retry after pre-analysis.....	38
	Pacemaker parameters and pulse widths.....	38
	Setting customized Analysis parameters before downloading	39

4	Screen structure and symbols.....	41
	Screen layout	42
	Tool buttons.....	43
5	Opening recordings and reports on the Recordings tab.....	45
	Using the "Search for" parameters to filter the patient and recordings list.....	46
	The Info and Status columns	46
	Opening long recordings	47
	Reports for separate recording blocks or the total recording	47
	Tabs available when opening the total report.....	48
6	Evaluation and correction on the Regions tab.....	51
7	Evaluation and correction on the Classes tab.....	55
	Assigned keys on the Classes tab.....	56
	The sections of the Classes tab	57
	Status display below the QRS class windows	57
	Display in an individual class window	58
	QRS zoom display.....	59
	ECG context display	60
	Regions in the ECG context display.....	61
	Measuring ECG sections.....	61
	Channel selection, Inverted waveform display, Colors	63
	Evaluation of the QRS class characteristics	64
	Additional class characteristic "1"	65
	Additional class characteristic "M"	65
	Correction of the QRS class characteristics	66
	Correction of characteristic assigned to a whole class – the asterisk [*].....	66
	Quick-Scan for quick evaluation and correction, splitting a QRS Class.....	67
8	Evaluation and correction on the Events tab	69
	Assigned keys on Events tab.....	69
	Analysis parameters and event classification	69
	Evaluation and correction of the event classification – overview	72
	Screen layout and operation of the Events tab.....	74
	Listing of events in the separate event classes.....	76
	QRS complex and switching tabs	77
	Reclassification of events using the + and – keys.....	77
	Designating an event to be an artifact	78
	RR interval or heart rate in the ECG context display	78
	Deleting and renaming event classes	78
	Adding a Patient diary event.....	79
	Heart Rate Turbulence [HRT]	80

	Quantifying of HRT by Turbulence Onset and Slope	80
	Background information / Relevance	81
	Setting the minimum and maximum RR intervals	82
	Editing events on the Classes tab	83
9	The HR Min/Max tab.....	85
	Display of “manual” events, i.e., events triggered at the recorder	85
	Evaluation and correction of the extreme heart rate values	86
	Adding an undetected QRS complex manually	87
	Accepting or changing extreme values automatically calculated	87
	Zooming in and out.....	88
10	The Statistics tab.....	91
	Mean heart rate and mean RR interval	91
	Diff. RR absolute.....	93
	Statistical calculation	93
	Background information / Relevance	94
	Diff. RR > 50 ms distribution	94
	Statistical calculation	94
	Background information / Relevance	95
	ST diagrams, evaluation and correction of the extreme values of the ST deviation.....	96
	PR trend	97
	QT analysis	98
	QT trend.....	99
	QT-RR distribution	101
	QT histogram.....	102
	AFib – Detection of atrial fibrillation.....	102
	Statistical calculation	102
	Background information / Relevance	102
	Explanation of the displays and color assignments.....	103
	Context menu options.....	104
11	The Report tab	105
	The software-generated Summary of the report	106
	The Diagnosis part of the report	107
	Printing a logo.....	108
12	The Full disclosure tab	109
13	The PM (Pacemaker) events tab	113
	Detectable pacemaker event classes.....	114
	Basis for the analysis and evaluation of pacemaker events.....	114
	Analysis algorithms of the stimulation impulse differentiation	114
	Effective stimulation in the ventricle (V-QRS).....	114

	Effective stimulation in the atrium (without oesophagus lead).....	115
	AV-sequential stimulation (A-Pace, V-Pace) without differentiation of the width of the stimulation impulse.....	115
	Exit block	115
	Oversensing	115
	Undersensing	115
	Fusion beats	115
	Independent transmission in DDD pacemakers (A-QRS).....	115
	Synchronous behavior of DDD pacemakers.....	115
14	The Heart rate variability tab	117
	Heart rate variability > Lorenz plot and Interval distribution	117
	Statistical calculation of the Lorenz plot	118
	Relevance of the <i>RR Lorenz plot</i>	118
	Statistical calculation of the interval distribution	118
	Relevance of the interval distribution	119
	Deceleration and Acceleration capacity	121
	Heart rate variability > RR histograms	121
	Heart rate variability > RR-FFT	123
	Statistical calculation	123
	Background information / Relevance	124
	Heart rate variability > 24h RR-FFT	126
15	The 12-channel ECG tab.....	129
	Screen structure and operation	130
	Measuring, editing, and exporting ECG sections	130
	Creating 12-channel markers	131
	General setup and print setup of 12-channel markers	131
	Automatic creation of markers.....	131
	Automatic Measurement.....	132
	Editing the automatically generated values	133
	Convert marker / Show recorder events	134
	Export of ECG sections, the Marker list.....	135
16	The Respiration tab.....	137
	The Analysis sub-tab	138
	Specification of the analysis period	139
	Start of analysis	139
	Evaluation and correction of the results of the respiratory analysis	140
	The Report sub-tab.....	141
17	The AFib tab – Frequency analysis for detection of atrial fibrillation	143
18	The TWA tab – T Wave Alternans.....	147
	Screen layout and operation	147
	Select analysis channels.....	149

Start analysis.....	149
Evaluation and correction of the TWA analysis.....	149
Valid and invalid TWA values	150
19 The Episodes tab – evaluation of episodes imported from an event recorder	151
20 The Print tab.....	153
Selecting a printer	154
Configuring a PDF file destination	154
Default and customized print selection templates.....	154
Printed check box.....	155
25 mm/s ECG strip settings	156
General > Report and Overview.....	156
Print > Full disclosure.....	159
Print > Saved events	161
Saved events > Overview 8 or 32 events/page	162
Saved events > 25 mm/s	162
Saved events > 1 min + 25 mm/s.....	164
Saved events > 10 min + 25 mm/s.....	165
Saved events > Patient diary	166
Print > Statistics	167
Statistics > General > QRS classes.....	167
Statistics > General > Event table	168
Statistics > General > Event histogram	168
Statistics > General > ST trend	170
Statistics > General > HR diagram + Min/Max minute	171
Statistics > General > PVC + SVE histograms.....	172
Statistics > General > Heart Rate Turbulence	173
Statistics > General > AC/DC Capacity	174
Statistics > Heart rate variability (Standard) > YT/PNN50	175
Statistics > Advanced heart rate variability (RR-FFT) > RR intervals	176
Statistics > Advanced heart rate variability (RR-FFT) > RR Lorenz plot	177
Statistics > Advanced heart rate variability (RR-FFT) > Min. sympathy. innervation index.....	179
Statistics > Advanced heart rate variability (RR-FFT) > 24 h RR-FFT	180
Statistics > Advanced heart rate variability (RR-FFT) > RR interval spectra.....	180
Statistics > PR/QT trend > PR trend	182
Statistics > PR/QT trend > QT-/QTc trend	183
Statistics > PR/QT trend > QT histogram.....	184
Print > Respiration > Overview and Marked episodes	185

Print > 12-channel ECG.....	187
Print > AFib > Statistic.....	188
Print > AFib > Frequency analysis	189
Print > Pacemaker.....	190
Pacemaker > Event histogram	190
Pacemaker > Function analysis.....	191
Statistical calculation	192
Relevance	192
Print > TWA > Trend.....	194
Print > TWA > ECG	195
Print > Event Recorder > Selected Marker.....	196

Part II – The CardioDay menus

21	The Recording menu.....	199
	Recording > Start.....	199
	Recording > Open... ..	199
	Recording > Reanalyze... ..	199
	Recording > Patient data.....	200
	Recording > Properties... ..	200
	Recording > Close recording	201
	Recording > Import.....	201
	Importing MARS Recordings.....	201
	Recording > Monitoring acquisition	202
	Recording > Delete	203
	Recording > Exit	204
22	The Recorder menu.....	205
	Recorder > Hookup.....	205
	Adding a recorder to the recorder list.....	206
	Establishing a connection to a device already in the recorder list	209
	Receiving or sending patient data	209
	Site and Location.....	210
	Processing MUSE orders	210
	Recorder settings for a recording, the Options field	211
	Viewing ECG waveforms and checking the signal quality.....	211
	Print diary.....	212
	Recorder > Transfer patient data.....	213
	Recorder > Download recording or Download long recording	214
	Recorder > Download event recording	214

23	The Export menu	217
	Export > Print to file	217
	Export > HRV data export.....	218
24	The Archive menu.....	219
	Selecting for archiving	219
	Selecting for Restoring.....	220
	Deleting recording(s) from the archive	220
25	The Extras menu.....	221
	Extras > Reanalyze events... ..	221
	Extras > Print screen	221
	Extras > Create 12-channel markers... ..	222
26	The Setup menu	225
	Setup > Screen, Scale, and Colors	225
	Setup > File path... ..	228
	Setup > RR-FFT options.....	229
	Setup > Other options	229
	Setup > Other options > Archive.....	230
	Setup > Other Options > Miscellaneous	231
	Setup > Other options > TWA.....	232
	Setup > Other options > MUSE connection.....	234
	Setup > Other options > Monitoring connection	235
	Setup > Report.....	236
	Customizing and saving report templates	236
	Setup > Report > Advanced.....	239
	Setup > 12-channel markers.....	242
	Setup > Printer.....	243
	Setup > Rebuild list of recordings	243
	Setup > Site and location administration.....	243
	Add site	244
	Add a location	245
	Editing a Site or Location	245
	Disabling a site or deleting a location.....	245
	Importing Sites and Locations from MUSE	246
	Setup > User administration.....	246
	Overview	246
	User administration for a new installation	247
	Adding a new user account.....	248
	Adding a new group account (for domain computers only).....	250
	Guest user rights on failed or canceled authentication	251
	Changing the default administrator password after installation.....	251

	Selectable user rights	251
	Site and Location management for users and groups	253
	Setup > Change user	254
27	The Help menu	255
	Help > Contents.....	255
	Help > Quick start guide	255
	Help > About.....	255
	Help > Version	255
	Help > Options	256
 Part III – Appendices		
A	Variables for customizing the report templates	259
	Patient data	260
	General data.....	260
	Analysis parameters	261
	Pacemaker-related analysis parameters.....	261
	Event data and measured values	262
	Heart rate variability parameters	266
	Heart Rate Turbulence and Deceleration capacity	267
	Combined variables	268
	Pacemaker data	269
	Information on the recording	269
	Information on recordings from an event recorder	270
B	Definitions.....	271
C	System limitations	273

1

Introduction

This document describes the CardioDay V2.5 Holter ECG Analysis Software and is intended for a trained physician or healthcare professional knowledgeable in Holter interpretation.

CardioDay is a software package that allows you, after having performed a long-term continuous electrocardiographic (ECG) recording on a digital flash memory Holter recorder, to download and analyze the data from the recorder, review it, and produce printed reports.

NOTE:

CardioDay does not perform any diagnosis of data by itself but only displays ECG morphologies and associated, calculated graphs such as heart rate trends, Heart rate variability, and other statistical values in graphical form. The physician will be able to review, edit, and print the data collected.

The ECG data are downloaded onto the software by either downloading them directly from a Holter recorder or by opening an existing data file. Once you have selected the data source and entered the patient information, CardioDay performs a pre-analysis on a short section of the ECG data file. The results of this pre-analysis are then presented. You may now view and, if necessary, edit the analysis parameters displayed in the **Signal evaluation and analysis parameters** window. After the analysis parameters have been reviewed and edited, CardioDay analyzes the complete ECG recording and presents the results. If you generally use the same parameters over and over again, you may store these values as **default** analysis parameters.

After performing the ECG analysis, CardioDay displays the **Regions** window for identifying artifacts. Then, in the **Classes** window, CardioDay has classified the QRS complexes into classes of similar morphology using specially designed algorithms. If, for example,

due to artifacts, it is necessary to reclassify a single beat or a particular class, then this can be done with just two clicks of the mouse. Once any corrections have been done, CardioDay automatically performs a new **Event analysis** based upon these changes and updates the list of cardiologically significant events.

The events detected by the software are weighted according to their significance and displayed in hierarchical order in the **Events** window. The most significant events from each event class are automatically marked for printing. As in the case of the QRS morphology classes, you must also view and validate the event classification and, if necessary, perform corrective action by editing the classes. To aid you in performing this task, a zoomed version of the selected QRS complex as well as the ECG context are simultaneously displayed on the computer screen. Furthermore, the **Events** tab allows you to evaluate and edit the detected minimum and maximum values of the RR interval and to quantify any **Heart Rate Turbulences** [HRT].

Other tab windows offer you powerful and easy to use tools for carrying out further assessments of your patients' ECG:

- The **HR Min/Max** tab allows you to check the minimum and maximum values of heart rate over the duration of the recording.
- The **Statistics** tab allows you to quickly view and assess graphical analysis results.
- The **Report** tab allows you to review a software-generated, tabular summary and to enter your diagnosis.
- The **Full disclosure** tab allows you to review a full disclosure of the raw ECG data at any time and thus enables you to validate the analysis results.
- The **Heart rate variability** tab allows you to use algorithms, including Fourier transformation of the complete ECG recording, that comply to internationally accepted standards to provide various types of information on the Heart rate variability of the patient's heart rate in graphical form.
- The **12-channel ECG** allows you to assess 12-channel ECGs.
- The **Episodes** tab allows you to assess imported event episodes.
- The **PM Events** tab allows you to analyze the pacemaker's mode of operation separately.
- The **Respiration** tab allows you to evaluate the results of an analysis CardioDay has performed on signals of impedance variations recorded by the respective version of CardioMem.

During the sleep phase these signals correspond to the respiration activity.

- The **AFib** tab allows you to evaluate the ECG data for possible signs of atrial fibrillation.
- The **TWA** tab allows you to analyze and evaluate the complete ECG recording for T Wave Alternans. This provides a variety of information on beat-to-beat alternans in the morphology of ST segment and T wave.
- The **Print** tab allows you to make your **Preselection** of the graphical displays and reports in the **Print Preview** before printing or before storing files.

Intended User

The CardioDay software is intended to be used by a trained physician or healthcare professional knowledgeable in Holter interpretation.

Intended Use

The CardioDay V2.5 Holter Analysis Software is designed for the acquisition, analysis, edit, review, report, and storage of ambulatory and multi-parameter ECG data.

Results of the automated analysis are intended to assist the physician in the interpretation of the recorded data. This information is not intended to serve as a substitute for the physician overread of the recorded ECG data.

The CardioDay V2.5 system is intended to be used by trained operators under the direct supervision of a licensed healthcare practitioner in a hospital or clinic environment.

Patient population includes both adult and pediatric human patients.

CardioDay V2.5 provides the user arrhythmia study and Holter analysis capabilities.

Data acquired may be used for the following indications:

- Evaluation of symptoms that may be caused by cardiac arrhythmia and/or conduction disturbances,
- Evaluation of symptoms that may be due to myocardial ischemia,
- Detection of ECG events that alter prognosis in certain forms of heart disease,
- Detection and analysis of pacemaker function and failure,
- Determination of cardiac response to lifestyle,
- Evaluation of therapeutic interventions,
- Investigations in epidemiology and clinical trials.

Contraindications

There are no known contraindications to using the device.

Prescription Device Statement

CAUTION

United States federal law restricts this device to sale by, or on the order of, a physician.

Regulatory and Safety Information

This section provides information about the safe use and regulatory compliance of this system. Familiarize yourself with this information, and read and understand all instructions before attempting to use this system. The system software is considered medical software. As such, it was designed and manufactured to the appropriate medical regulations and controls.

NOTE:

Disregarding the safety information provided in this manual is considered abnormal use of this system and could result in injury, data loss, or a voided warranty.

Safety Conventions

A **Hazard** is a source of potential injury to a person or damage to property or the system.

This manual uses the terms WARNING, CAUTION, and NOTICE to point out hazards and to designate a degree or level of seriousness. Familiarize yourself with the following definitions and their significance.

Definition of Safety Conventions

Convention	Definition
WARNING	Indicates a potential hazard or unsafe practice, which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a potential hazard or unsafe practice, which, if not avoided, could result in moderate or minor injury.
NOTICE	Indicates a potential hazard or unsafe practice, which, if not avoided, could result in the loss or destruction of property or data.

Safety Hazards

The following messages apply to the system as a whole. Specific messages may also appear elsewhere in the manual.

Warnings

WARNING:

GENERAL RISK TO PATIENT HEALTH AND LIFE - The life or health of a patient may be put at risk if the medical personnel do not have all the information contained in the operator manual.

Carefully read the operator manual. It contains important information for a correct ECG analysis.

WARNING:

MIXING UP RECORDINGS - The life or health of a patient may be put at risk if a different patient's examination is assigned to this patient, thus resulting in an incorrect diagnosis.

Take special care to always select the correct examination and correct patient in the software. To ensure that a recording is not assigned to the wrong patient, always enter the patient's ID into the recording medium or write the patient's ID on the medium before starting the recording.

WARNING:

USING THE RESULTS OF THE AUTOMATIC ANALYSIS FOR DIAGNOSIS - Using the results of the automatic analysis for diagnosis without first validating them may put the patient's life or health at risk.

The ECG morphology classification and events resulting from the automatic analysis of the ECG data by CardioDay must not be used for diagnostic purposes before they have been validated by a trained physician or healthcare professional experienced in Holter ECG analysis.

In addition, it is extremely important that you view and validate the raw ECG data (**Full disclosure** tab) and that you do not rely solely on the analysis results generated by the software itself. For example, strong interference fields, movement artifacts, or loose electrodes may influence the signal morphology and produce classes or events that are not consistent with the patient's actual heart condition.

Cautions

CAUTION:

AMBULATORY DATA - Ambulatory ECG data from Holter recorders are not intended to be used as a substitute for a standard diagnostic quality resting 12-channel ECG.

Do not use the 12-channel data of CardioDay as diagnostic quality resting 12-channel ECG.

CAUTION:

RISK OF SIGNAL INTERFERENCES BY ELECTROSTATIC DISCHARGE – Possible electrostatic discharge of electrical devices can interfere with the signals of the ECG waveforms.

Do not touch the patient and the computer or its accessories simultaneously. Accessories include keyboard, mouse, printer, or any other device connected to the computer.

Notices

NOTICE:

POSSIBLE LOSS OF BLUETOOTH CONNECTION - If you use any unauthorized Bluetooth wireless equipment, optimum wireless performance cannot be assured.

Be aware that a Bluetooth connection can be disconnected or interrupted, if the Bluetooth wireless technology has not been tested and verified using this equipment.

NOTICE:

MALFUNCTIONING OF THE BLUETOOTH CONNECTION – To ensure that the correct Bluetooth module is used, it can become necessary to disable an internal Bluetooth module on the computer.

If your computer's internal Bluetooth module cannot connect to the recorder, disable the module and use the Bluetooth USB adapter.

NOTICE:

POSSIBLE LOSS OF BLUETOOTH CONNECTION – Bluetooth connections can be disturbed by WLAN connections.

Understand that the wireless transfer process cannot be guaranteed under all circumstances when using Bluetooth wireless technology.

NOTICE:

INTERFERENCE WITH OTHER WIRELESS EQUIPMENT - Other devices could interfere with the equipment, even if they comply with CISPR emission requirements.

Understand that range loss can occur if Bluetooth wireless technology and other RF devices (e. g., WLAN) devices are used near each other.

NOTICE:

UNRELIABLE PERFORMANCE – All electronic equipment can be infected by malicious software.

GE Healthcare products are scanned for viruses before they are delivered. To ensure they remain virus-free, we recommend implementing the following precautions:

Install a good quality virus scanning program and regularly update it.

Initiate procedures to prevent infected software reaching your computer, e.g., check the source of any software you use, use only original software packages and, if possible, use your PC solely for use with CardioDay.

Do not install CardioDay onto a computer that is used for downloading information from the Internet.

NOTICE:

DATA LOSS – Data are not completely safe when they are stored for a prolonged period.

We recommend regularly storing patient and recording data using appropriate storage procedures.

Supply and Accessory Information

For ordering information and a list of supplies and accessories that have been approved for use with this device, see the supplies and accessories manual that is supplied with your recorder.

Manufacturer Responsibility

The manufacturer is responsible for the effects of safety, reliability, and performance only if the following conditions are met:

- Assembly operations, extensions, readjustments, modifications, or repairs are carried out by persons authorized by GE Healthcare.
- The electrical installation of the relevant room complies with the requirements of the appropriate local, state, and other government regulations.
- The equipment is used in accordance with the instructions for use.

Product and Package Information

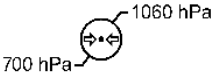
This section describes the location of the labels used on the packaging of your device. It also describes the symbols used on the labels.

Symbols

The following symbols may appear on the packaging. Familiarity with these symbols assists in the safe use and disposal of the equipment. For equipment symbols not shown, refer to the original equipment manufacturers (OEM) manuals.

Symbols are used to convey warnings, cautions, prohibitions, mandatory actions, or information. Any hazard symbol on your device or packaging with markings in color indicates there is certain danger and is a warning. Any hazard symbol on your device or packaging that is in black and white indicates a potential hazard and is a caution.

Symbol	Description
	Catalog or Orderable Part Number Indicates the manufacturer's catalog or part number.
	Serial Number Indicates the manufacturer's serial number.
	Manufacturer Name and Address Indicates the name and address for the manufacturer of this device.
Rx Only	Rx Only US Federal law restricts this device to sale by or on the order of a physician.
	Follow Instructions for Use Read and understand the operator's manual before using the device or product. As a mandatory action sign, this symbol is identified by a blue background and white symbol.
CE 0197	CE Mark The CE Mark and Notified Body Registration Number signifies the device has met all essential requirements of European Medical Device Directive 93/42/EEC.
	PCT (GOST-R) Mark Indicates the device or product conforms to applicable Russian Gosstandard technical and safety standards.
	CAUTION CONSULT ACCOMPANYING DOCUMENTS – There may be specific warnings or precautions associated with the device that are not otherwise found on the label. Consult the accompanying documentation for more information about safely using this device.
	Fragile Indicates the contents are fragile. Handle with care.

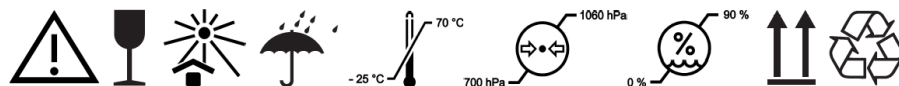
Symbol	Description
	Keep away from sunlight Indicates that you must keep the device away from direct sunlight.
	Keep Dry Indicates that you need to keep the container away from rain and other sources of moisture.
	Temperature limits Indicates the upper and lower temperature limitations for the transportation and handling of this package.
	Pressure limits Indicates the upper and lower air pressure limitations for the transportation and handling of this package. The limits are indicated next to upper and lower horizontal line.
	Humidity limits Indicates upper and lower humidity limits. They are indicated next to the upper and lower horizontal lines.
	This way up Indicates the correct upright position of the package.
	Capable of being recycled Indicates you may recycle this material or device. Recycle or dispose of in accordance with local, state, or country laws.

Labels on the product package

This section identifies the labels on the product package. See the “[Symbols](#)” section on page 18 for detailed descriptions.

The product label identifies the following information for shipping:

- Product description
- Serial number
- Regulatory compliance
- Manufacturer and distributor information



Packaging label

The packaging label contains handling, cautionary information, and disposal symbols.

Service Information

This section provides information pertaining to the maintenance and servicing of the system. Familiarize yourself with this information before requesting service from GE Healthcare or its authorized representatives.

Service Requirements

It is the user's responsibility to report the need for service to GE Healthcare or to one of their authorized agents.

Additional Assistance

GE Healthcare maintains a trained staff of application and technical experts to answer questions and respond to issues and problems that may arise during the installation, maintenance, and use of this system.

Contact your local GE Healthcare representative to request additional assistance.

Manual Information

NOTE:

This manual explains all CardioDay features. Note that some features may not be included in the standard package and must be purchased separately. Furthermore, some options, as well as recorder types, might not be available in your region. To get more information about available options, please contact your local GE representative.

This section provides information for the correct use of this manual.

Keep this manual with the equipment at all times and periodically review it. Request training assistance from GE Healthcare, if needed.

Manual Purpose

This manual provides information necessary for the configuration and safe operation of this equipment in accordance with its function and intended use. It is not intended as a replacement for, but a supplement to, thorough product training. Keep it with the equipment at all times. Additional manuals can be found on the manual DVD of CardioDay or can be downloaded online. To access other manuals online, go to www.gehealthcare.com/documents and click Cardiology.

Document Conventions

This document uses the following conventions.

Typographical Conventions

The following table identifies the typographical conventions used in this document, other GE Healthcare Diagnostic Cardiology product documents, and third-party product documents distributed by GE Healthcare Diagnostic Cardiology.

Convention	Description
Bold Text	Indicates keys on the keyboard, text to enter, or hardware items such as buttons or switches on the equipment
<i>Italicized Bold Text</i>	Indicates software terms that identify menu items, buttons, or options in various windows.
KEY1+KEY2	Indicates a keyboard operation. A plus (+) sign between the names of two keys indicates that while holding the first key, you should press and release the second key. For example, "Press Ctrl+Esc " means to press and hold the Ctrl key and then press and release the Esc key.
Enter	Indicates that you must press the Enter or Return key on the keyboard. Do not type Enter .
<space>	Indicates that you must press the spacebar. When instructions are given for typing a precise text string with one or more spaces, the point where you must press the spacebar is indicated as: space . This ensures that the correct number of spaces is inserted in the correct positions within the literal text string. The purpose of the < > brackets is to distinguish the command from the literal text within the string.
>	The greater than symbol, or right angle bracket, is a concise method to indicate a sequence of menu selections. For example, the statement "From the main menu, select System > Setup > Options to open the Option Activation window" replaces the following: 1. From the main menu, select System to open the System menu. 2. From the System menu, select Setup to open the Setup menu. 3. From the Setup menu, select Options to open the Option Activation window.

Illustrations

All illustrations in the document are provided as examples only. Depending on system configuration, screens that appear in the document may differ from the screens as they appear on your system.

Notes

Notes provide tips or additional information that, while useful, are not essential to the correct operation of the tools. They are called out from the body text through a flag word and indentation:

Related Documents

The following documents are referenced in this manual and provide additional information that may be helpful in the configuration, maintenance, and use of this product.

- *CardioDay V2.5 Pre-Installation Manual*
- *CardioDay V2.5 Customer Installation Manual*
- *CardioDay V2.5 Installation and Field Service Manual*
- *CardioDay V2.5 Quick Start Guide*
- *CardioDay V2.5 Privacy and Security Manual*

2

The optimal path for Holter / Ambulatory ECG evaluation

CardioDay is state of the art software for Holter ECG evaluation. This manual, split into parts I, II and III, provides you with guidelines to obtain results very quickly, even though CardioDay offers a great diversity of special functions.

- Part I provides all the information necessary for evaluating Holter ECG recordings including:
 - Downloading recordings, including how to set the **Analysis parameters** for the pre-analysis of a short segment of the recording.
These parameters can be adapted for the final analysis.
 - Using the **Recordings** tab to open stored recordings and reports.
Filters are available to search for specific recordings or patients.
 - Evaluating the noise regions detected during analysis using the **Regions** tab.
You can also manually mark other regions of a recording that you do not want to have analyzed.
 - Evaluating the ECG QRS/Beat classifications and QRS complex groups via the **Classes** and **Events** tabs.
 - Using the **Report** tab to write your diagnosis, which is available for printing and archiving together with a software-generated summary of the relevant cardiologic data.

The remaining tabs are used for special research and analysis features. These features may be purchased as extensions to CardioDay.

- Part II explains all of the main CardioDay application menus:
 - The **Recording** menu, where you can open or import the recording files, analyze them, or edit the associated patient data.
 - The **Recorder** menu, where you can download Event and Holter recordings, transfer patient demographic data to connected Holter recorders and provides an ECG waveform Hookup preview function.

Additionally, for the downloading of long Holter recordings (duration of more than 48 hours), a separate sub-menu is available.

The **Hookup** function of this menu allows for the use of an online/connected Holter recorder to check the ECG signal quality and electrode placement prior to starting a recording.
 - The **Export** menu, where you can generate a PDF file or export the data to another computer.
 - The **Archive** menu, where you can archive recordings and evaluation results to and restore them from local or network locations.
 - The **Extras** menu, where you can perform additional tasks, e.g., reanalyze an open recording and edit the analysis parameters for this.
 - The **Setup** menu, where you can customize the software according to your own requirements.
- Part III contains the manual appendices and includes the following sections:
 - List of the variables for customizing the **Report** templates,
 - List of definitions,
 - Table of system limitations.

Part I

—

Downloading and evaluating Holter ECG recordings

3

Downloading ECG data

NOTE:

Before an analysis can begin, the data stored in the recorder must be downloaded onto the computer.

NOTE:

To enter event recordings that have been recorded using the CardioMem CM 3000 L3, refer to "[Recording > Import...](#)" on page 201.

A recording is downloaded from a recorder or from a memory card. Before the recording is analyzed, you can accept or change the analysis parameters. You can repeat the analysis at any time with changed parameters.

NOTE:

To download recordings, you need the **Download recording** right assigned to your user credentials.

To overwrite an existing recording with a newly downloaded one, you additionally need the **Delete recording** right assigned to your user credentials.

For details on user rights refer to "[Setup > User administration...](#)" on page 246.

Recorder memory card types

- CardioMem CM 3000 and the SEER 12 series recorders use removable memory cards. For downloading recordings and patient data, a Compact Flash Card Reader is required.
- CardioMem CM 4000, SEER 1000, SEER Light, and SEER Light Extend series recorders have non-removable memory cards. For downloading recordings and patient data, the recorder is connected to the PC via the integrated USB interface.

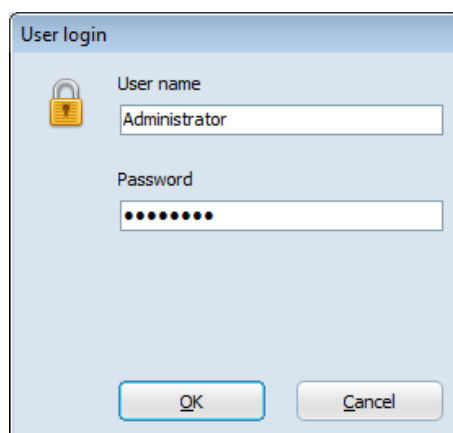
Program start, User login

Use either of the following methods to start CardioDay:

- From the Windows Start Menu, select **Programs > GEHC > CardioDay**
- On the computer desktop, double-click the CardioDay icon.



For authentication and to assign user rights, CardioDay prompts the user for a **User name** and a **Password** upon starting the program.



User login

To log on as a local CardioDay user, enter the **User name** and **Password** of your local CardioDay account.

You can also log on to CardioDay via Single Sign-on (SSO) by using the user name and password of your Windows account. This requires that a matching CardioDay group account be configured in the CardioDay user management (for details, refer to “[Setup > User administration...](#)” on page 246).

If the “Auto logon” feature is activated for a CardioDay account that is associated with your Windows account, CardioDay will not ask you for user name and password. You can refer to the CardioDay status bar at the bottom of the main window to check the account that was automatically used to identify you on CardioDay.

NOTE:

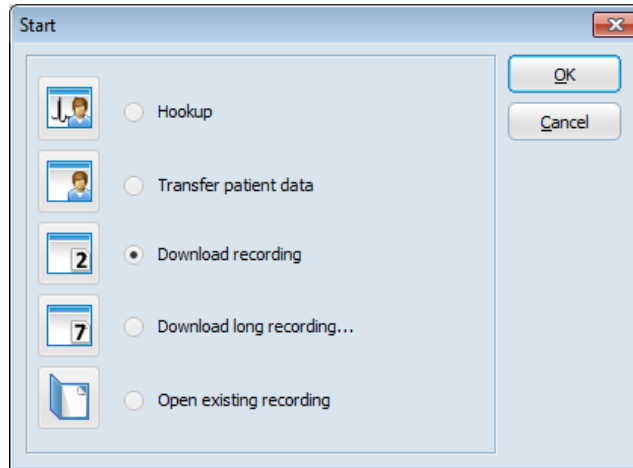
At the time of installation, the CardioDay administrator default password is **14012013**. After the installation is complete, change the password as described in the “[Setup > User administration...](#)” section on page 246.

For recorders of the SEER 1000 series, always use the same administrator password to connect to the recorder from all

software programs (iOS App, PC App, CardioDay, and Cardio-Read). This password is stored on the recorder along with the patient data to protect it against unauthorized use.

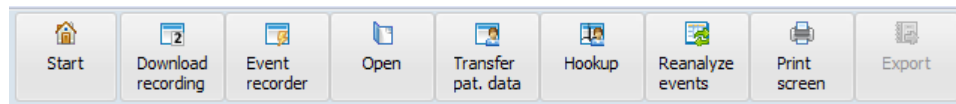
Start window options

The following window appears once the program has been started:



Start window

The **Start** window can be opened via the **Start** Icon at the top of the main application window. The individual **Start** menu functions are also available via the icons and **Recording** and **Recorder** menus at the top of the main application window.



- The **Hookup** feature can be used, depending on the recorder type, via Bluetooth connection or via USB connection to view and check the signal quality of the electrodes attached.

A Bluetooth connection can be established with CardioMem CM 4000, SEER 1000, and CM 3000-12 BT recorders.

A USB cable connection can be established with CardioMem CM 3000-12 and SEER 12 recorders.
- The **Transfer patient data** feature allows you to enter and store patient data onto the recorder or memory card prior to the start of the recording.
- The **Download recording** feature and—for recordings of more than 48 hours—the **Download long recording** feature are used to download ECG data from a Holter recorder and store them on a Holter recording storage slot presented in the **Download data** window. For details, refer to the “[Download recording](#)” section on page 30.

If there is at least one free recording slot for an additional recording, a line marked **Free** will be displayed at the top of the list.

If no **Free** recording slot is available, the system will select the oldest slot file to be overwritten. Before accepting that selection, check the file's **Status** to confirm it is eligible for deletion. If the file is not eligible, select one that is by clicking on it. Regardless of which slot file is selected, you receive a warning that you are about to overwrite data and must confirm the selection before proceeding.

When downloading long recordings, you must take into account the information contained in the section about "[Opening long recordings](#)" on page 47.

- The **Open existing recording** feature allows you to open a recording already stored on your PC or in the network.

Selecting the recording slot for the patient's ECG recording

NOTE:

To overwrite recordings, you need the user or user group right **Delete recordings** assigned to your user credentials.

For details on user rights, refer to "[Setup > User administration...](#)" on page 246.

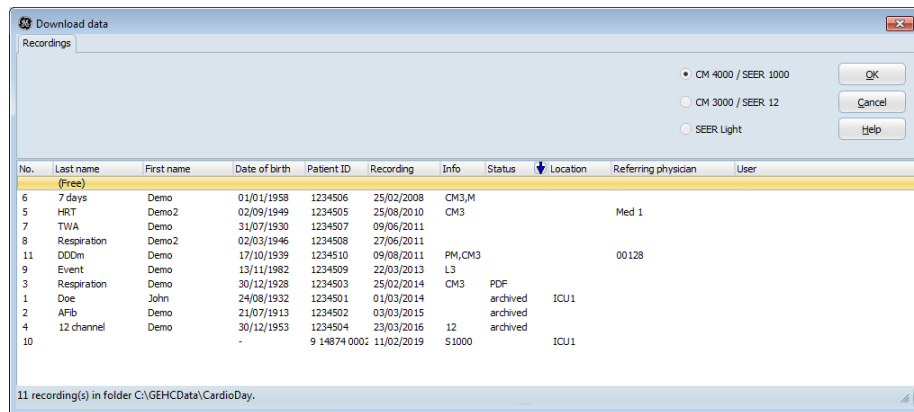
Download recording

To download data from the Holter recorder, select **Download recording** (or **Download long recording** for recordings of more than 48 hours) in the **Start** window.

A window containing the list of recording slots will be displayed. This will include an entry for each Holter recording stored by the CardioDay system. Each list item will describe the patient demographics, the recording details and status as well as the active user that may have a recording open.

NOTE:

If the user chooses to overwrite an existing recording slot, the user will be presented a warning to either accept or cancel the overwrite/delete operation.



Recording slots for storing ECG recordings

By default, 100 recording slots are available for downloading and storing ECG recordings, although the number of available recording slots can be as high as 4095. For information on how to change the number of recording slots refer to the *CardioDay V2.5 Installation and Field Service Manual*.

If a free recording slot is available, it will be marked “**Free**” at the top of the list. Otherwise, you need to select an older recording from the list that can be overwritten.

Recordings are automatically sorted according to date when the window is opened, with oldest recordings listed at the top.

Sorting the list of patient names

If you click the column heading, the list of patient names will be organized according to this criterion. For example, if you click the **Last name** field, the patients are listed alphabetically according to name. If you click it again, the order of the list is reversed, i.e., the alphabetical list runs from Z to A. This function is valid for all column headings except **First name** and **User**.

Entering patient data

NOTE:

To enter patient data, you need the user or user group right **Edit patient data** assigned to your user credentials.

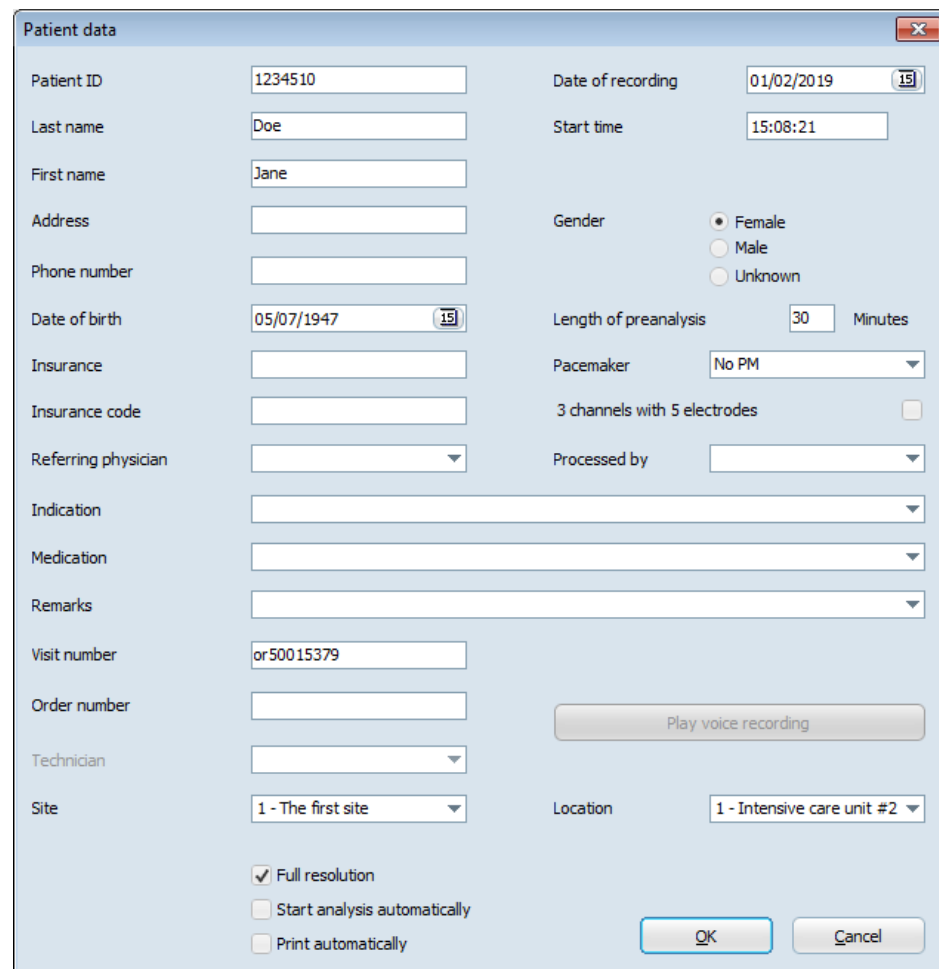
For details on user rights, refer to “[Setup > User administration...](#)” on page 246.

NOTE:

Review your local government, regulatory and institution security and privacy rules for handling of Patient Health Information (PHI). Laws and restrictions (HIPAA) may state that you must have written permission to access or enter PHI into an Electronic Database or a Clinical system.

After you have selected a free recording slot for recorder download, the template for entering patient data opens. This template can be accessed at any time through the menu **Recording > Patient data**.

If you transfer data prior to performing a recording, the entire or parts of the template transferred may contain data.

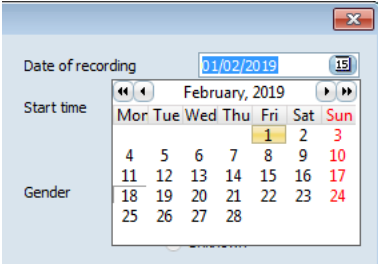


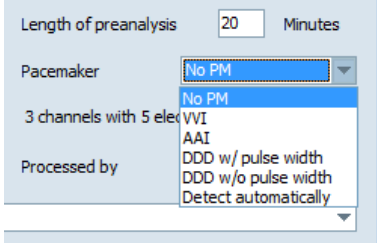
The screenshot shows a 'Patient data' window with the following fields and options:

- Patient ID:** 1234510
- Last name:** Doe
- First name:** Jane
- Address:** (empty field)
- Phone number:** (empty field)
- Date of birth:** 05/07/1947
- Insurance:** (empty field)
- Insurance code:** (empty field)
- Referring physician:** (dropdown menu)
- Indication:** (dropdown menu)
- Medication:** (dropdown menu)
- Remarks:** (dropdown menu)
- Visit number:** or50015379
- Order number:** (empty field)
- Technician:** (dropdown menu)
- Site:** 1 - The first site
- Date of recording:** 01/02/2019
- Start time:** 15:08:21
- Gender:** Female (selected), Male, Unknown
- Length of preanalysis:** 30 Minutes
- Pacemaker:** No PM
- 3 channels with 5 electrodes:** (checkbox, unchecked)
- Processed by:** (dropdown menu)
- Location:** 1 - Intensive care unit #2
- Analysis options:**
 - ☒ Full resolution
 - ☐ Start analysis automatically
 - ☐ Print automatically
- Buttons:** Play voice recording, OK, Cancel

Patient data window

The fields are mainly self-explanatory, except for the following fields:

Field	Description
Date of recording	 Click the symbol that is displayed at the top right of the window to select the monthly calendar. The displayed date format changes depending on the Language and Regional settings of your Windows installation.
Length of pre-analysis	Designates the period of time at the beginning of the ECG recording used by CardioDay to check the quality of the signal and to select optimum analysis parameters (channel, amplification, and so on). The minimum value is 12 minutes.
Full resolution	Determines whether the data is downloaded from the recorder in its native resolution. The option should only be unchecked if there is limited archive space available. If unchecked the downloaded data is downsampled to 128 Hz / 8 Bit.
Start analysis automatically	Determines whether the Signal evaluation and analysis parameters window is not displayed and the analysis of the recording is performed using the default analysis parameters.
Print automatically	Determines whether the analysis results are printed immediately after the automatic analysis process is completed. The hardcopies generated correspond to the default print selection previously defined.
Start time	Determines whether a preceding recording segment will be excluded from the analysis. You can change the original Start time if you know that the signal is distorted in the first part of a recording. If you do not change the Start time, you can also delete these regions later on the Regions tab.
3 channels with 5 electrodes	Determines whether a third, computed channel will be displayed if only 2 channels have been recorded. The calculation of the third channel is performed in analogy to that of the third limb lead in Einthoven's Triangle.

Field	Description
Pacemaker	Determines the type of pacemaker used. If you have purchased the Pacemaker analysis option, the pacemaker events will be displayed on the PM tab. If you do not know the pacemaker type, select the Detect automatically option.  NOTE: The Type of pacemaker option cannot be stored on the SEER Light and SEER Light Extent recorder. This field will default to No PM on download of the recording. If information about a pacemaker is available, set the correct pacemaker type, otherwise leave the value No PM. If the recording contains pacemaker data, you can reanalyze the recording any time with proper pacemaker settings.
Site number / Location number	Set the Site and Location for the recording. The Site and Location assigned to the current user will be available in the drop-down menu. The default Site and Location of the current user is selected automatically. If no default Site and Location is assigned to a user, Unknown is selected by default. You can select any other available Site and Location. The selection of Unknown assigns the recording to no Site and Location and makes it visible to all users. For details, refer to “Setup > Site and location administration...” on page 243 and to “Site and Location management for users and groups” on page 253.

Patient data window field descriptions

If CardioDay is connected to the CardioMem CM 4000 recorder, which supports the **Voice recording** feature, the **Play voice recording** field is activated.

Signal evaluation and setting of Analysis parameters before downloading the ECG data

NOTE:

If the **Start analysis automatically** button is checked in the **Patient data** window, the window for **Signal evaluation and setting of analysis parameters** does not open and the recording is downloaded directly. You can proceed as explained in “[Opening recordings and reports on the Recordings tab](#)” on page 45.

When you confirm the patient, recorder and download options entered by pressing **OK** in the **Download data** window, the ECG data

as given by **Length of pre-analysis** is read. The program automatically selects—depending on screen size and grid setting—a section of a few second's length. This section is displayed in the context window and, using these data, the internal start parameters of the program are initialized.

If no ECG signals have been recorded within the **Length of pre-analysis**, the pre-analysis should be repeated with a longer **Length of pre-analysis**, e.g., 60 minutes.

In the lower part of the window you can examine the ECG section of interest. The individual setting options are described below.

Signal evaluation and analysis parameters

Signal evaluation during pre-analysis

After the pre-analysis, a window opens in which you can evaluate the pre-analysis results, in particular the suggested evaluation channel and the sensitivity of each of the two channels.

Duration of recording

If the recorder has been removed before the end of the set recording duration without having been switched off, you can use this entry to set the indicated **Duration of recording** to the actual recording duration and exclude artifacts from the download. You can also use the **Regions** tab after the pre-analysis in order to remove any noise regions or flat lines. This is explained in “[Evaluation and correction on the Regions tab](#)” on page 51.

QRS classification

After evaluating the signal, the program suggests a channel that will be used as the primary analysis channel in the 2-channel QRS classification.

Sensitivity

Change the sensitivity only if necessary. In most cases the default setting of **Medium** gives best analysis results. However, take the following into consideration when evaluating sensitivity:

- If the signals have amplitude of less than 0.7 mV, you can set the sensitivity to **High**.

- If the signals have amplitude of more than 2 mV, you can set the sensitivity to **Low**.
- If a recording has a high T wave amplitude, it might happen that CardioDay will trigger those T waves as QRS complexes. In order to avoid this, you can set the sensitivity to **Low**.
- If a channel is turned off, it will not be analyzed.
- If you set a channel to **off / fft**, this channel will only be included in the algorithm classification of the beats if a QRS complex was detected on the analysis channel at the same time.

Noise detection

If you select the **Noise detection** option, noisy regions of a recording that have been detected in both channels are marked automatically for your evaluation and, if necessary, correction on the **Regions** tab.

If you select the **Noise detection** option, noisy regions of a recording that have been detected in one channel only are marked automatically for your evaluation and, if necessary, correction on the **Events** tab in the **Noise** event line.

If a region is automatically classified as noise but you disagree and want to have this region included in the analysis, you need to manually remove this region.

For additional information, refer to “[Evaluation and correction on the Regions tab](#)” on page 51.

NOTE:

When changing the noise suppression setting, the original data will not be modified. Use this function to remove noise regions from recordings with very high noise.

QRS differentiation

The **Normal** parameter is suitable for most recordings. The following parameters can be selected:

- **Sensitive**
- **Normal (default)**
- **Insensitive**

Your selection affects the QRS classification that CardioDay carries out followed by the event analysis. If you select **Sensitive**, more QRS classes will be formed than with the **Normal** parameter in the automatic analysis for your subsequent evaluation and correction. If you select **Insensitive**, fewer QRS classes will be formed.

Default parameters set

Additional **Analysis parameters** can also be modified and set for this analysis or **Saved** as part of the **Default** analysis parameters used in future recorder downloads.

Analysis parameters		
Tachycardia threshold SV	200	bpm
Tachycardia threshold V	80	bpm
Bradycardia threshold	70	bpm
Pause	1500	ms
Prematurity SV	80	%
Prematurity V	90	%
R on T (relative to 1 s)	320	ms
Delayed QRS complex	140	%
Refractory period	220	ms
Minimum beat count for SVE tachycardia	3	
Report template	Standard	

Example for pediatric cardiologic analysis parameters

You can select a **Default** of the parameters displayed in the windows for individual patient groups. These parameters are explained in the “[Analysis parameters and event classification](#)” section on page 69.

You can customize the default set of parameters and store them using **Save as default** under the name you selected in the **Default parameter set** field. After activating this field using the right mouse button, you can also enter a new name.

You can also select an additional set of analysis parameters that are available for specific patient groups or analysis methods.

The default selections are:

- **Standard**
- **Pacemaker**
- **Child up to 12**
- **Child up to 1**
- **Arrhythmia**
- **User1**
- **User2**

Suppress SVEs during AFib episodes

If you select this option, supraventricular extrasystoles are not classified by CardioDay as events if, at the same time, atrial fibrillation is present. For additional information, refer to “[AFib – Detection of atrial fibrillation](#)” on page 102.

Minimum beat count for SVE tachycardia

With this setting you determine the minimum number of beats with which an event is classified as **SVE tachycardia**. If you set the value

2, an event of two SVEs with a heart rate higher than the set **Tachycardia threshold SV** is counted as a **SVE tachycardia**.

If you want to include the SVE Couplets and SVE Triplets in the final report, the **Minimum beat count for SVE tachycardia** must be set to 2.

Report templates

In CardioDay V2.5, you can store customized **Report templates**.

During pre-analysis, you can select the **Report template** that will be used during subsequent analysis. If no customized templates have been generated, the default template will be used.

For additional information, refer to “[The software-generated Summary of the report](#)” on page 106.

Overview and Retry after pre-analysis

If you click the **Overview** button, the segment of the ECG waveforms defined by **Length of pre-analysis** setting is displayed in the workspace.

While in the ECG waveform **Overview** workspace, clicking the **Return** button will return you to the **Signal evaluation and analysis parameters** settings window.

If you press the **Retry** button after having changed parameters, the pre-analysis is performed again with the updated parameters.

Pacemaker parameters and pulse widths

Enter the pacemaker parameters and select the pacemaker type. If the type is not known, select **Detect automatically**. (It is possible to enter the other parameters after having viewed the ECG.)

Pacemaker parameters and pulse widths

Enter the parameters for automatic pacemaker analysis:

- **Type**
- **Base rate**
- **Max. rate**

- **Hysteresis** (absolute minimum rate)
- **Maximum AV time** (atrioventricular delay, atrioventricular time interval)

If a pacemaker with different pulse widths in the atrium and in the ventricle has been used, you can additionally enter the limits of the detected pacemaker pulse widths. (The pulse width differentiation allows better analysis results, especially for noisy recordings.)

If you click the **Histogram** button, the pulse widths detected in the ECG are displayed.

If you click the **Evaluate histogram** button, the limits of the detected pacemaker pulse widths from the histogram are used for the complete recording. You can save the pacemaker settings—together with the other analysis parameters—as the default by clicking the **Save as default** button.

Setting customized Analysis parameters before downloading

If you confirm the signal evaluation suggested by CardioDay and the current **Analysis parameters** by clicking **OK**, the entire ECG recording will be downloaded.

This process, which is visualized with a progress bar, takes approximately 1 to 3 minutes, depending on recording duration, recorder type, and computer performance.

If, when starting work with CardioDay, you at first want to use the available **Defaults** for specific patient groups, you can select them here and gain initial experience with the analysis parameters. For additional information on the individual **Analysis parameters** refer to [“Analysis parameters and event classification”](#) on page 69.

NOTE:

For a new signal evaluation, you do not need to download the ECG data again. Using the **Recording > Reanalyze** menu option you can reanalyze the original data. All results already stored for the recording are discarded.

4

Screen structure and symbols

This chapter presents the screen structure that CardioDay displays after a recording has been opened for evaluation.

If you select **Start > Open existing recording**, the **Recordings** tab opens where you select and open a patient's recording. (On the **Recordings** tab, you can also open additional recordings after having finished an evaluation.)

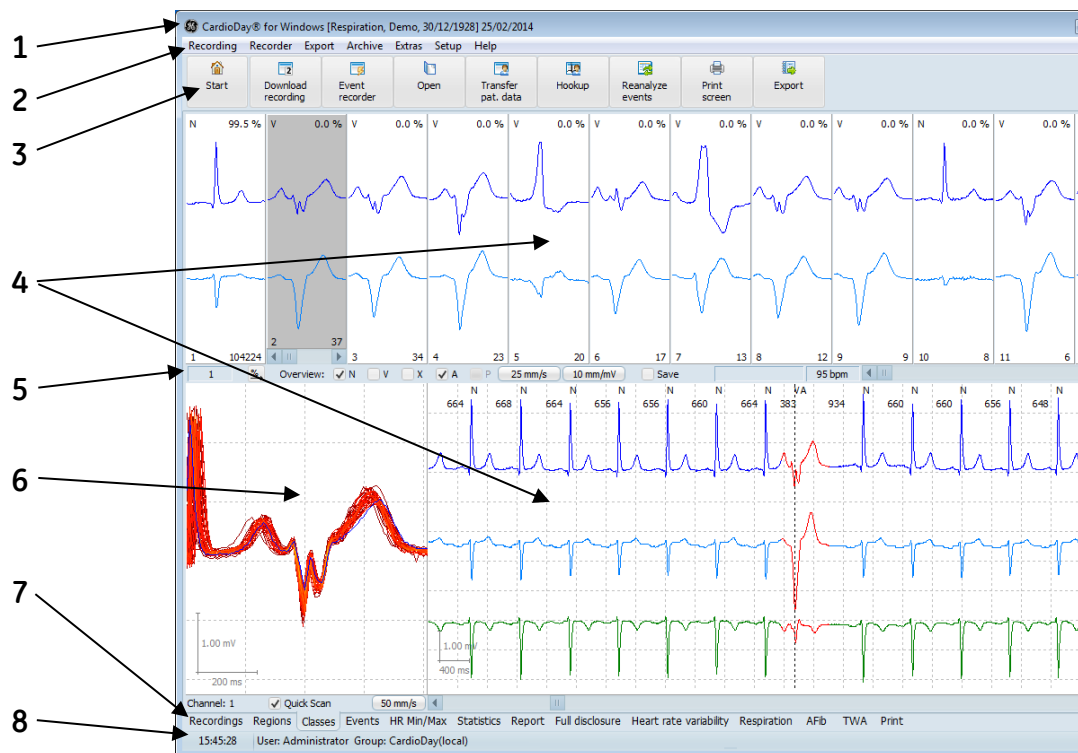
If you open a recording, the **Regions** tab opens, followed by the **Classes** tab, which is used as an example in this chapter. The screen structure changes from tab to tab.

NOTE:

If some labels are not completely displayed, the **Large Fonts** setting is selected under **Display** in the Windows Control Panel. Select the **Small Fonts** setting.

Screen layout

Following is an overview of the screen layout. The layout is similar on the different tabs. This section does not provide details.



Structure of the CardioDay screen

The CardioDay screen is divided into the following items:

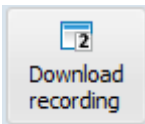
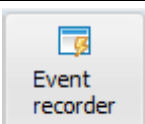
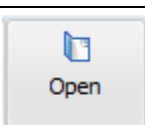
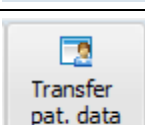
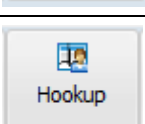
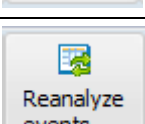
1. The title bar contains the name of the program, the name and date of birth of the patient currently being edited, and the date of the recording.
2. The menu bar presents the individual functions of the program in functional groups. We recommend that you get to know CardioDay using the menu bar. Later you will be able to access the most important functions faster by clicking tool icons.
3. The toolbar presents tool icons for the most frequently used functions, which in this way can be accessed directly with one mouse click.
4. The upper and lower workspace areas change depending on the tab and the status of the evaluation. In the upper workspace area, among other things, QRS classes (as in the example above) or event histograms are displayed. In the lower workspace area, the ECG context is displayed on most tabs.
5. The status bar displays various program and file status information. For additional information, refer to "[Status display below the QRS class windows](#)" on page 57.

6. The lower workspace area provides information that is more detailed. For example, on the **Classes** tab in the QRS zoom display, you can view a single QRS complex or all the complexes of the selected class superimposed upon each other. The ECG in the vicinity of the selected QRS complex is displayed on the right-hand side.
7. The tab bar allows for simple and fast switching between the tabs by clicking with the mouse. The individual working steps of the Holter ECG evaluation are distributed over special tabs. It is recommended to work through the tabs in the order displayed.

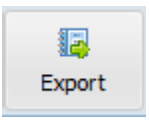
Pressing the **F2** function key will switch to the respective next tab.
8. The info bar displays the time of the active QRS complex as well as the **User** and **Group** names.

Tool buttons

Tool buttons allow quick access to frequently used options also found as a menu or as an option of the **Start** window. For further information, please refer to the respective sections.

 Start	"Start window options", page 29
 Download recording	"Downloading ECG data", page 27
 Event recorder	"Recording > Import...", page 201
 Open	"Recording > Open...", page 199
 Transfer pat. data	"Entering patient data", page 32
 Hookup	"Recorder > Hookup", page 205
 Reanalyze events	"Extras > Reanalyze events...", page 221

Screen structure and symbols

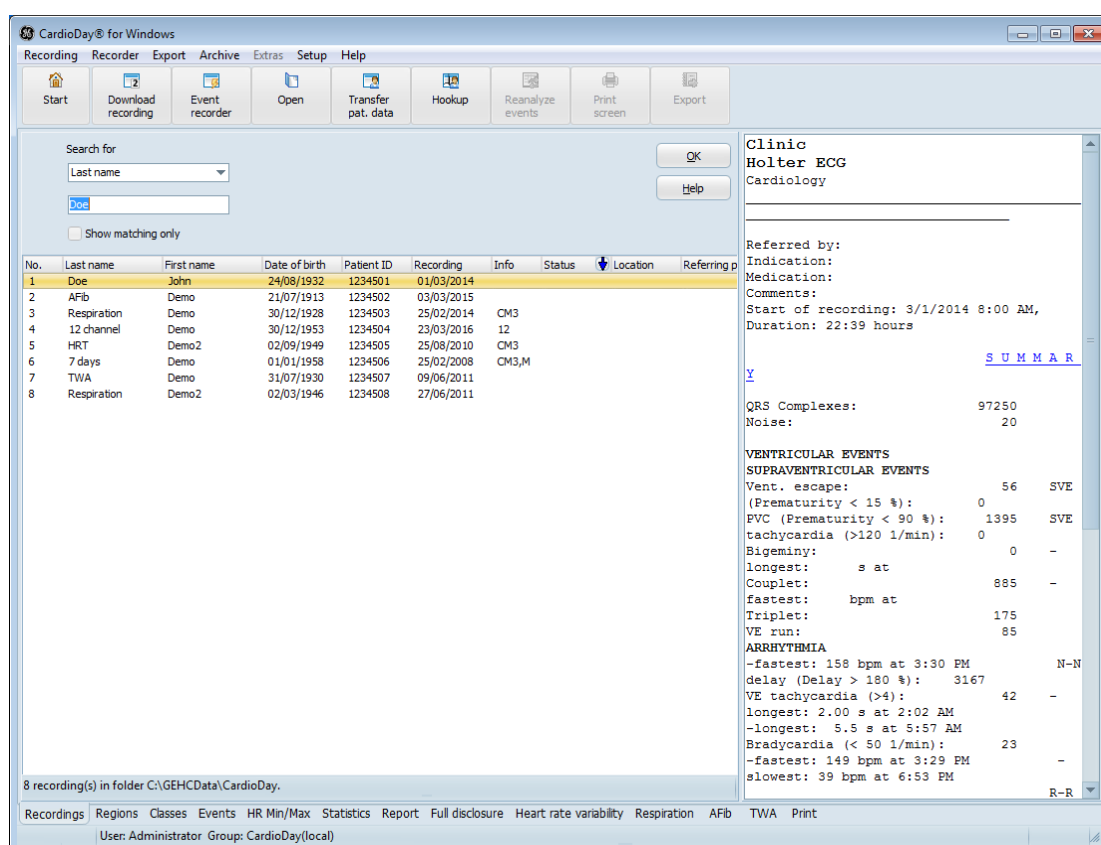
 Print screen	"Extras > Print screen", page 221
 Export	This button refers to different export locations like MUSE, GDT interface, or WorklistCommander. For additional information, refer to the <i>CardioDay V2.5 Installation and Field Service Manual</i> .

5

Opening recordings and reports on the Recordings tab

The **Recordings** tab can be opened in one of two ways:

- From the **Start** window, select **Open existing recording**, or
- From the **Recording** menu, select **Open**.



The Recordings tab

After completing an evaluation, you can select additional recordings on the **Recordings** tab.

If you open a selected recording, the **Regions** tab opens, followed by the **Classes** tab. The screen structure changes from tab to tab.

Using the "Search for" parameters to filter the patient and recordings list

You can use the filter criteria **Last name**, **Patient ID**, **Referring physician** and **Location** to search for recordings.

If you enter a letter or number in the empty field **Search for**, the first entry beginning with that letter or number will be found.

If you select **Show matching only**, only the recordings matching the filter are displayed.

On this tab, the reports of the stored recordings are displayed without these recordings having been opened.

The Info and Status columns

Most of the columns on the **Recordings** tab are self-explanatory, but the following columns require additional explanation.

Under **Info** you find additional information about the recording, e.g., whether it contains 12-channel (**12**) or pacemaker (**PM**) information.

The following table identifies and describes possible values in the **Info** field.

Value in <i>Info</i> column	Meaning
PM	Pacemaker
12	12-Channel
L3	Event recorder
CM100	Event recorder
CM3	CM 3000
CM4	CM 4000
M	Long recording (multi day)
S1000	SEER 1000
SLight	SEER Light, SEER Light Extend
MARS	MARS recording
Monitor	Monitoring acquisition

Under **Status** you find the following recording status indicators:

Status	Description
Diagnosed	The diagnosis written on the Report tab has been reviewed, which is confirmed by checking the Diagnosed checkbox.
Printed	The recording has been printed to a configured print location.
Archived	The recording has been stored on an Archive location. (See " Setup > Other options > Archive " on page 230.)
PDF	The recording has been stored to a PDF file location. (See " Configuring a PDF file destination " on page 154.)
MUSE	The recording report has been stored to a MUSE system. (See " Setup > Other options > MUSE connection " on page 234.)

Opening long recordings

A recording that is longer than 48 hours and downloaded as a long recording is automatically split into 24-hour or 48-hour blocks.

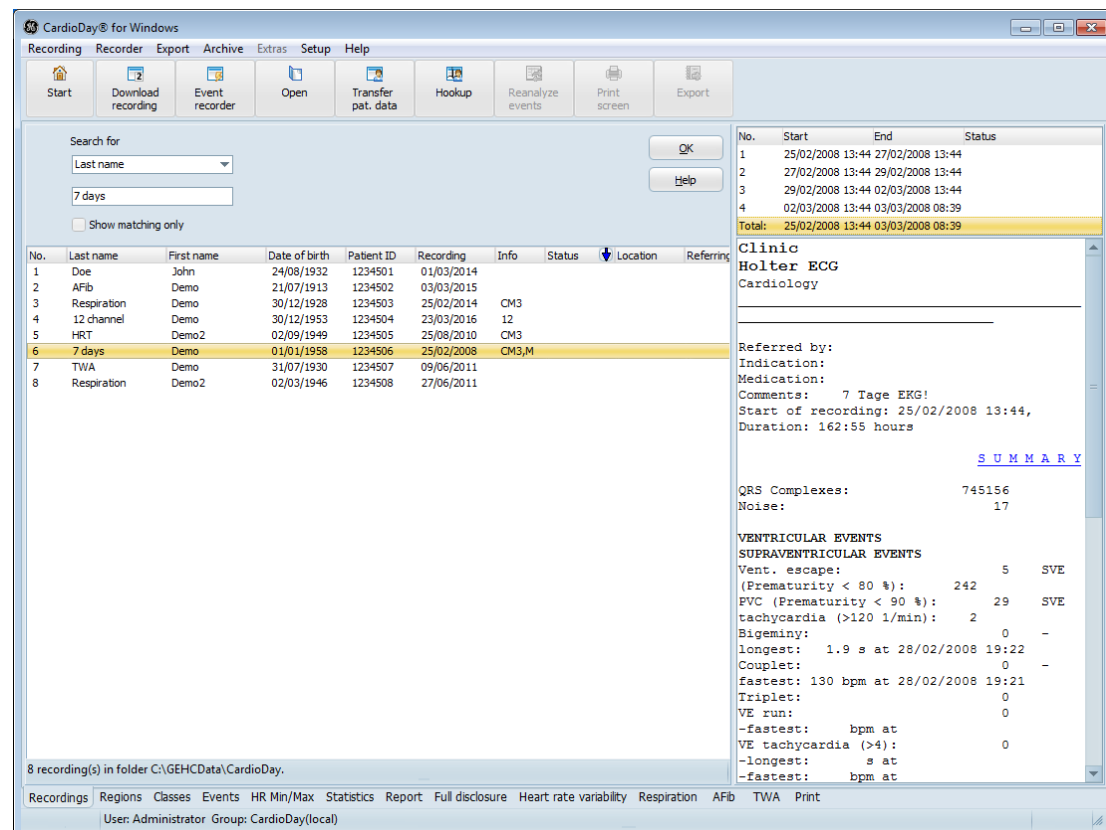
Reports for separate recording blocks or the total recording

If you select a long recording in the patient list, the separate recordings are displayed above the report on the right side of the window. For every selected recording block, the report is displayed.

From the list of recording blocks displayed in the upper right side of the window, you can select/open individual recording blocks. For each individual recording block opened, the standard working step tabs will be available for Holter ECG evaluation.

At the end of the list, you can select **Total** to view a report for the total recording. This report serves as an overview and does not contain all details of the usual reports. If you open the **Total** recording with a double click, only certain tabs with a reduced number of sub-tabs are offered for evaluation.

Opening recordings and reports on the Recordings tab



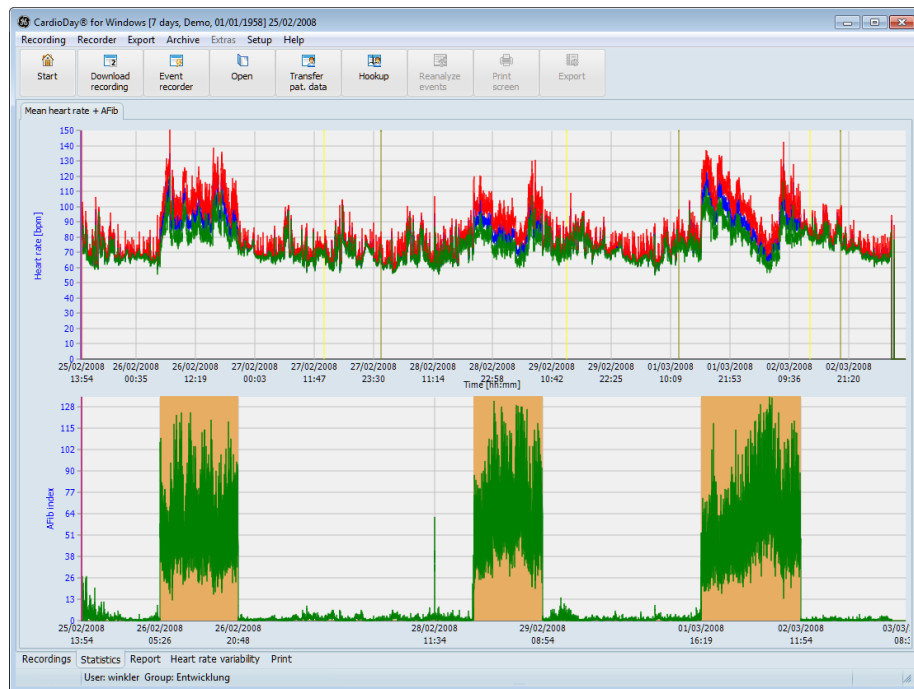
The Recordings tab, recording blocks of a long recording

Tabs available when opening the total report

When opening the total report of a 7-day recording, the following tabs are available.

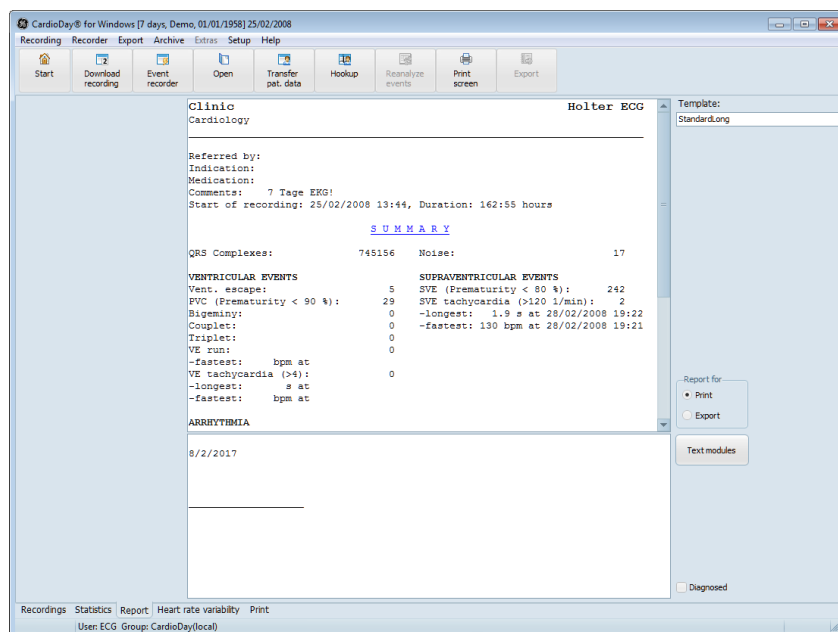
The **Statistics** tab displays the heart rate trend chart over the complete 7 days in the upper part of the screen. Yellow lines show the separation between the single days.

The lower part of the screen shows the atrial fibrillation index. If a period of AFib has been detected during the recording period, it will be indicated by a yellow highlighted area. With a double-click in this AFib area, CardioDay will open the corresponding 24-hour block so that you can perform the Holter analysis on that selected day.



Statistics tab for a long recording

The **Report** tab displays the summary of all events detected over the complete recording duration. Furthermore, the strips that were saved for the reports in the **Events** tab of each recording block can be selected for the printout.



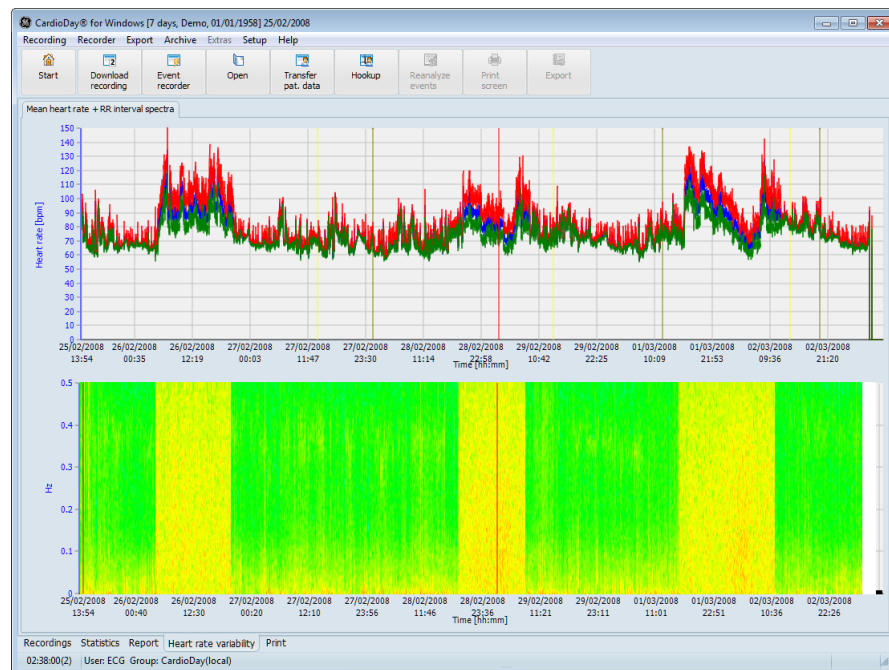
Report tab for a long recording

The **Heart rate variability** tab displays the heart rate trend chart over the complete 7 days in the upper part of the screen. Yellow lines show the separation between the single days.

The lower part displays the Heart rate variability over the 7-day period. The **RR interval spectra** provide an overview of the results of

Opening recordings and reports on the Recordings tab

the spectro-temporal RR interval analysis in subsequent 5-minute time segments. For additional information, refer to “[Statistics > Advanced heart rate variability \(RR-FFT\) > RR interval spectra](#)” on page 180.



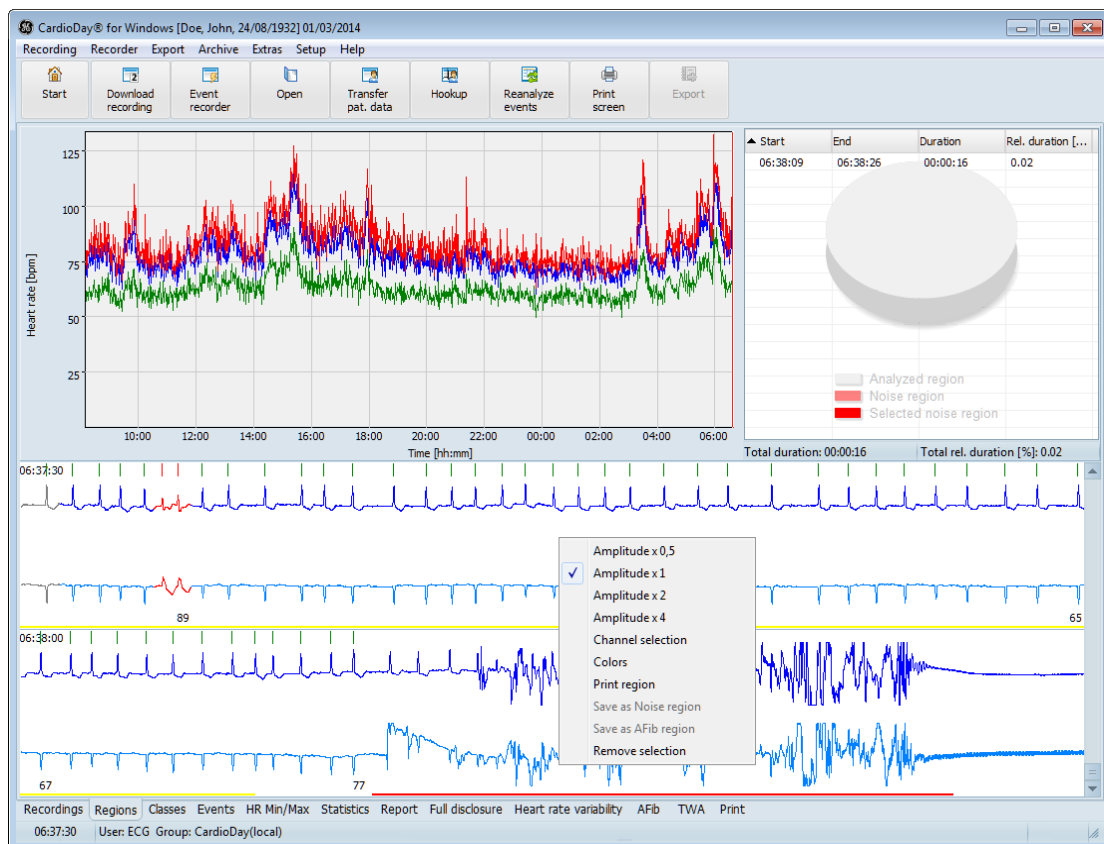
Heart rate variability tab for a long recording

6

Evaluation and correction on the Regions tab

On the **Regions** tab you evaluate the noise regions detected by CardioDay. You can mark with the mouse other regions of the recording that you do not want to have analyzed.

You can mark regions either in the heart rate trend curve in the upper left area of the screen or in the ECG context display in the lower area of the screen. In the ECG display, you also can directly determine regions of atrial fibrillation.



The Regions tab

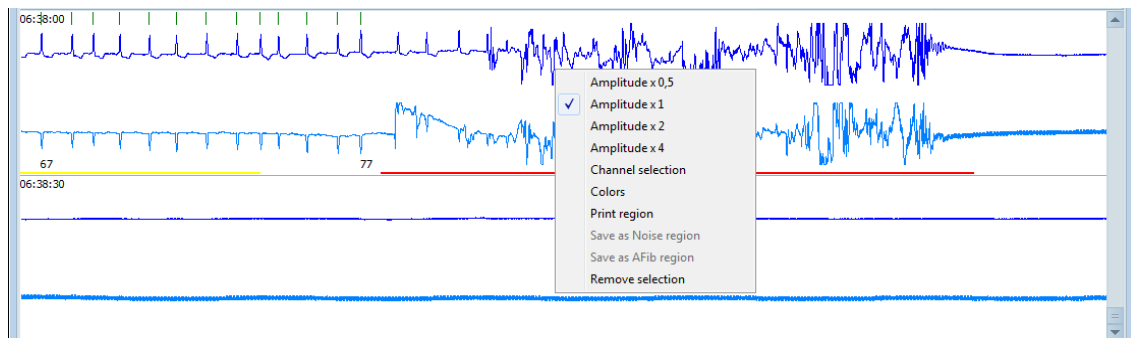
NOTE:

Noise regions are not included in the analysis. You have to remove regions marked as noise from the **Regions** tab if they should be analyzed.

Noise regions marked on the **Regions** tab are shown on the **Full disclosure** tab by a red line.

If, during downloading, you have selected the option **Noise detection** in the window **Signal evaluation and analysis parameters**, noisy ECG regions are automatically marked and shown on the **Regions** tab.

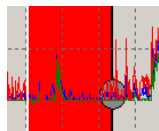
- In the heart rate trend graph, you can create only noise regions.
- In the ECG context graph, you can create both noise and atrial fibrillation regions.



ECG context display with context menu

The following actions are available when marking regions:

- To activate the zoom function, drag the mouse pointer diagonally over the heart rate histogram.
- To mark a new noise region, drag the mouse pointer parallel to the time axis over the histogram. When you start dragging the mouse, a small circle will appear around your mouse pointer. As long as the mouse pointer is inside the circle, you mark a region; when the mouse pointer leaves the circle, the zoom function is activated. In the ECG context display, the marked region is shown by a red line.



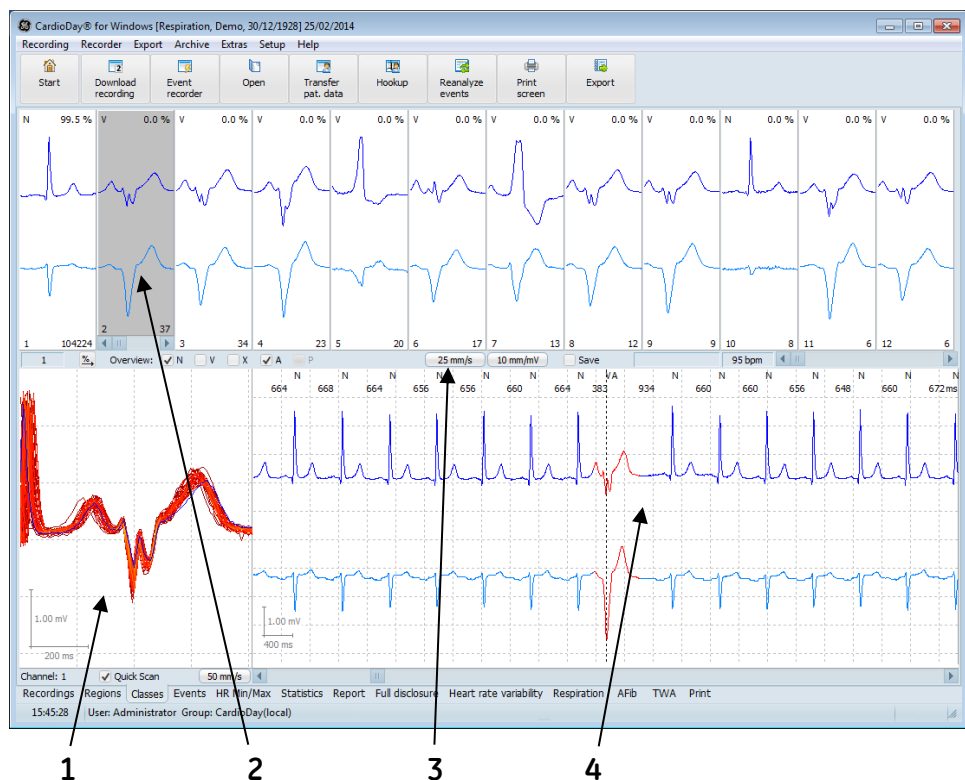
- To mark a region for storage as either a noise region or an atrial fibrillation region, drag the mouse pointer over the ECG context display, open the context menu, and select **Save as noise region** or **Save as AFib region**.

- To open the context menu, right-click on the region marker in the ECG context display. From the context menu, you can do the following:
 - **Remove** the **selection** of the marked region.
 - Select the zoom factor of the **Amplitudes**.
 - Perform the **Channel selection**.
 - Select the **Colors** of the waveform display.
 - Select **Print region** to open a print preview of the marked region.
- To remove a region marking, you can also highlight the entry in the list on the upper right area of the screen and press the **Delete** button.

7

Evaluation and correction on the Classes tab

The **Classes** tab displays the results of the QRS classification carried out by CardioDay after having downloaded and analyzed the data. The workspace is divided into several sections.



Workspace of the classes tab

1. QRS Zoom Display
2. QRS Class
3. Status Bar
4. ECG Context Display

The results displayed on the **Classes** tab are based on time and frequency calculations. Following evaluation and any necessary corrections by a healthcare professional trained in Holter interpretation, the QRS classes are also the basis for the subsequent classification and evaluation of rhythm events.

If you are already familiar with the evaluation and editing of the QRS classification, you can accelerate your evaluation work as explained in [“Quick-Scan for quick evaluation and correction, splitting a QRS Class”](#) on page 67.

Assigned keys on the Classes tab

The following keyboard shortcuts can be used on the **Classes** tab:

Keyboard shortcut	Function
N	declares the active single QRS complex as a normal beat
V	declares the active single QRS complex as a ventricular beat
X	declares the active single QRS complex as an aberrant beat
P	declares the active single QRS complex as a pacemaker beat
A	declares the active single QRS complex as an artifact
Enter	marks next QRS class window
Ctrl+Enter	marks QRS class window to next screen
Ctrl+S	saves ECG strip to the report
Backspace	marks preceding QRS class window
Ctrl+Backspace	marks QRS class window to preceding screen
Arrow right/down	switches to next QRS complex
Arrow left/up	switches to preceding QRS complex
Del	declares marked QRS class as Normal / Artifact / Aberrant / Paced / Ventricular (switching function)
Ctrl+G	opens the Enter time window for selecting the specific time point that will be displayed in the ECG context window.

NOTE:

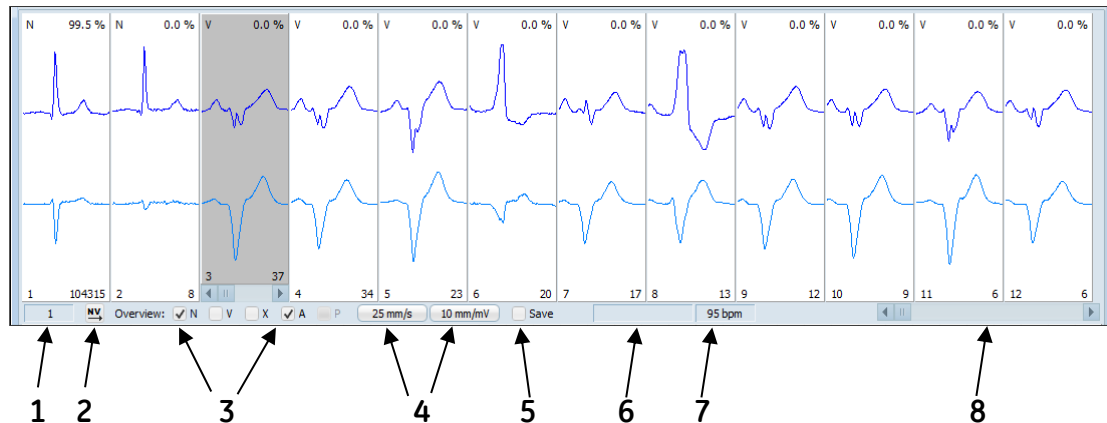
The combined classes for manually edited single beats with characteristic NM, VM, XM, PM, or AM cannot be edited. For details refer to [“Additional class characteristic “M””](#) on page 65.

The sections of the Classes tab

Status display below the QRS class windows

Classes are listed in order of the number of beats within a class, starting with the highest. You can change the sorting criteria and list the classes in order of class type. You can move between classes using the scroll bar or **Enter** key.

The status bar is located below the QRS class section and above the QRS zoom and ECG context display:



QRS class section with status display

1. QRS Complex – Displays the sequential number of the QRS complex within the QRS Class displayed.
2. The sorting button allows you to change the sorting criteria for the classes. You can choose between the number of beats within a class or the class type.
3. **Overview** – Check the **Overview** box to limit a QRS class characteristic to a maximum of four classes. The four classes represent the four possible polarity combinations of the two ECG channels, i.e., positive-positive, positive-negative, negative-positive, and negative-negative.

NOTE:

For most of the cases, we recommend only QRS complexes with the characteristics N and A be combined. If, for example, V and X are combined, this can make your evaluation of the QRS classification in many cases more difficult.

4. Zoom settings – Sets the zoom settings of the ECG context display (lower half of the screen):

Time scales:

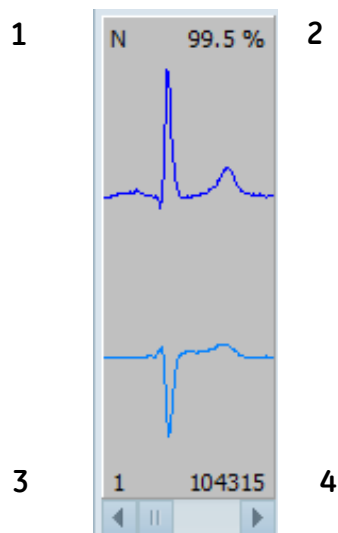
6.25 mm/s, 12.5 mm/s, 25 mm/s, 50 mm/s, 100 mm/s

Amplitude scales:

5 mm/mV, 10 mm/mV, 20 mm/mV, 40 mm/mV

5. **Save** checkbox – Indicates whether the active QRS complex has been saved to the final report. Change the status by clicking with the mouse. Check the **Save** checkbox to save a strip to the final report.
6. Event display – Identifies whether the active QRS complex belongs to an event. Click on the event designation to correct the assignment. Values displayed in the event display include the events as evaluated on the **Events** tab.
7. Heart Rate – Displays the heart rate in beats per minute. The value is determined as a moving average over 10 QRS complexes with the displayed QRS complex being the last complex. The Heart Rate value cannot be edited.
8. Scroll bar – Displays the various QRS class sections if they do not all fit onto the screen.

Display in an individual class window



Individual class with parameters

For each class the following is displayed:

1. The characteristic of this QRS class assigned by the program, abbreviated as N (Normal), V (Ventricular), X (Aberrant), P (Paced, Stimulated) or A (Artifact).
The class characteristics are explained together with the ["Evaluation of the QRS class characteristics"](#) on page 64.
2. The percentage of the total number of QRS complexes assigned to this class.
3. The class number.
4. The number of QRS complexes in this class.

If the class contains multiple QRS complexes, a scroll bar is displayed at the bottom edge of the QRS class.

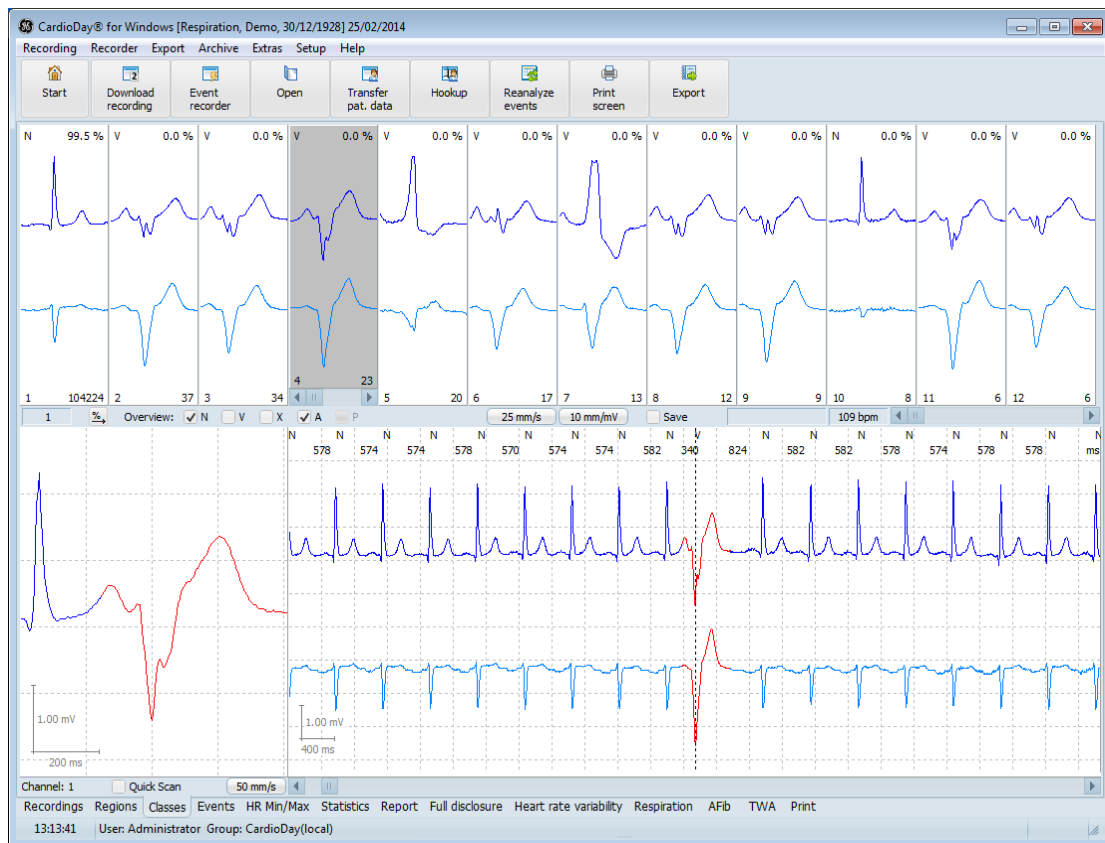
The sequential number of the currently active QRS complex in the selected QRS class is displayed at the far left of the status bar below the QRS class section (see “[Status display below the QRS class windows](#)” on page 57).

Since the display is always synchronized to the R peak, small deviations within the class are easily recognized, even when quickly scrolling through the QRS classes.

When a QRS class is selected, you can also use the “left” and “right” horizontal arrow keys to scroll through the class contents.

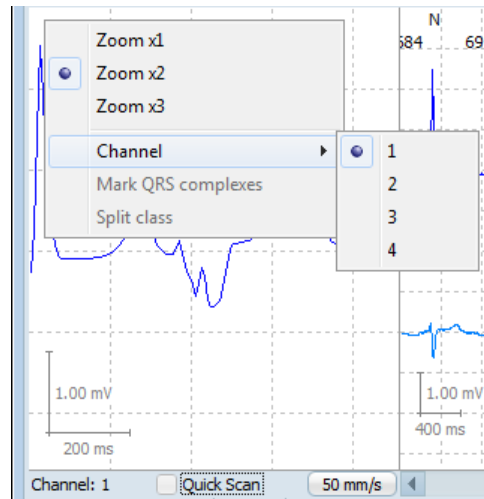
QRS zoom display

The QRS zoom display on the left-hand side in the lower workspace area is used for more precise estimation of the QRS complex and the P wave shown in the active class.



Highlighted QRS class

If the Quick-Scan function (see [“Quick-Scan for quick evaluation and correction, splitting a QRS Class”](#) on page 67) is not activated, the QRS zoom display will show an enlarged version of the QRS complex currently displayed in the highlighted class bin. Use the right mouse button to open a context menu, which allows you to select the zoom factor and the displayed channel.



QRS zoom display with context menu for zoom factor and channel selection

For additional information about the QRS zoom display refer to [“Quick-Scan for quick evaluation and correction, splitting a QRS Class”](#) on page 67.

ECG context display

The ECG context display in the right-hand side of the lower workspace area is used for the evaluation of the surrounding environment of the active QRS complex.



ECG context of the selected QRS complex

The active QRS complex is displayed centered to its R peak, which is marked by a dashed line. The letters above or below the complexes designate their current classification. The numbers between the R peaks show either the RR interval in milliseconds (ms) or its reciprocal value, heart rate, in beats per minute (bpm).

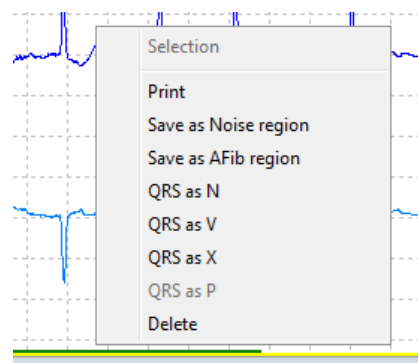
You can use your mouse to interact with the screen in the following ways:

- To toggle between RR interval and Heart Rate, double-click close to the values.
- To change the time of an R-peak, click and drag the dashed line.
- To enter an additional R-peak, open the context menu by right-clicking in the ECG context display and selecting **Insert QRS mark**. In this way a **Normal** beat is inserted. You can change the classification, if necessary, as explained in the section “Additional class characteristic “M”” on page 65.

Regions in the ECG context display

To mark a region in the ECG context display, click on the region to select it and then right-click on or above the green line in the region to open the context window.

The newly marked region will be displayed with a line at the bottom. For regions marked as noise, the line will be red. For regions marked as AFib, the line will be yellow. Right-clicking a region marker allows for printing or deleting the marker.

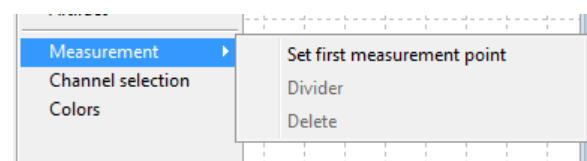


Context menu in the ECG context display

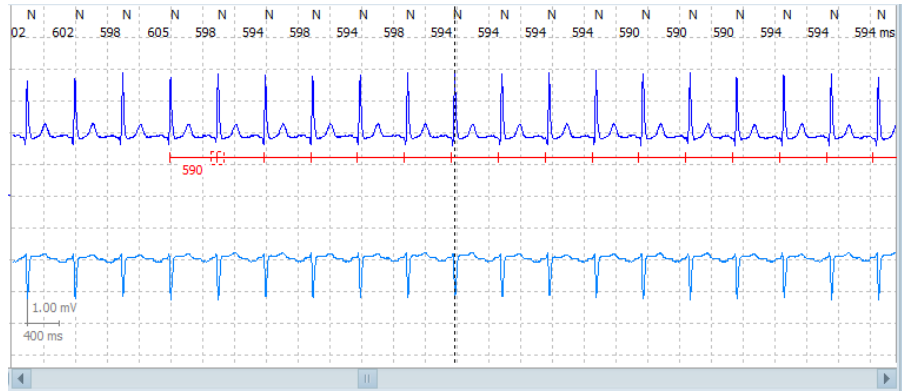
Measuring ECG sections

You can easily measure the duration of selected ECG sections and the amplitude of beats of interest.

Mark two positions in the ECG context display by clicking on them while pressing the **Ctrl** key or, alternatively, using the context menu: the horizontal axis displays the time difference in milliseconds whereas the vertical axis displays the amplitude difference in mV.



Context menu in the ECG context display > Measurements



ECG context of the selected QRS complex with marking

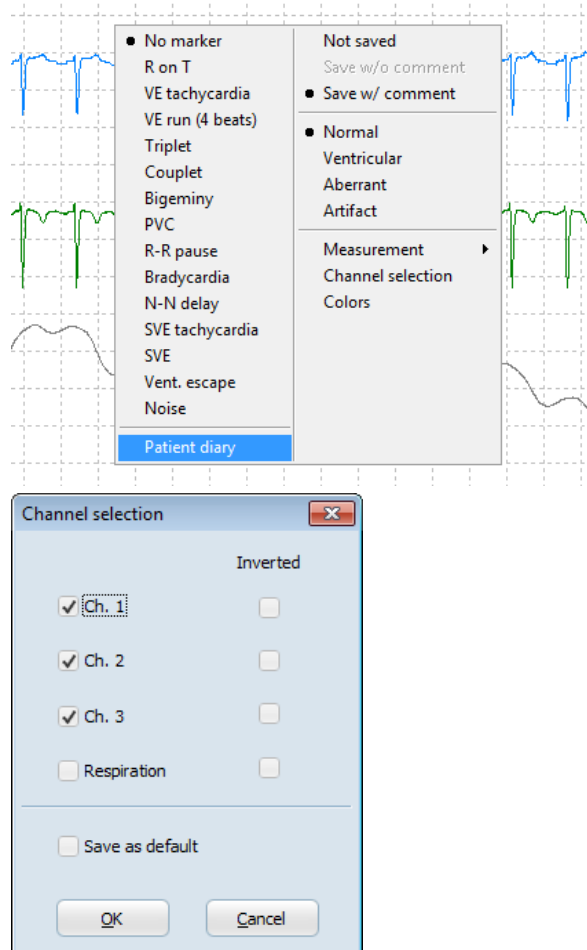
To measure time or amplitude, press **Ctrl+Shift** at the same time and left-click on the desired starting point. If you hold down the **Ctrl+Shift** keys and click on a second point, a line will appear on the screen connecting the two points. A horizontal line will be drawn if the horizontal distance is larger than the vertical distance and vice-versa.

You may edit the time and amplitude measurement lines using the mouse or keyboard as follows:

- To select a measurement line, left-click at the endpoint of one of the lines or at the intersection point of two lines. When you click an endpoint, a double arrow symbol is displayed. When you click an intersection point between two lines, a quadruple arrow symbol is displayed.
- To move a time or amplitude line, click the endpoint of the desired line and drag the double-arrow symbol in the direction you want to move the line.
- To move both the time and amplitude lines, click the intersection point between the two lines and drag the quadruple-arrow symbol in the direction you want to move the lines.
- To move the endpoint of a selected line, click on the endpoint, hold the **Ctrl** key, and use the **left**, **right**, **up**, and **down** arrow keys.
- To insert or remove repetitive measurement lines, select the line, hold the **Ctrl** key, and press the **z** key.
- To delete a selected measurement line, use the **Ctrl+Delete** key combination or context menu.

Channel selection, Inverted waveform display, Colors

If you right-click with the mouse in the ECG context display, a context menu opens where you can carry out **Channel selection**.



Context menu in the ECG context display and channel selection window

Left-clicking on **Channel selection** opens another window.

In the **Channel selection** you can select which channels will be included in the ECG display and also select their display polarity.

NOTE:

You can also modify the waveform display colors via the “[Setup > Screen, Scale, and Colors](#)” window, as explained on page 225.

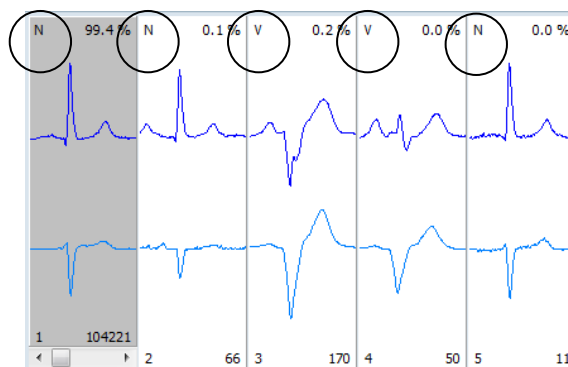
Evaluation of the QRS class characteristics

Evaluate and, if necessary, correct the QRS classification carried out by CardioDay.

NOTE:

It is especially important to review the evaluation of the QRS classes characterized as VENTRICULAR and ABERRANT. If a beat from an aberrant class occurs close in time to a ventricular or to another aberrant beat, the aberrant beat is included in the evaluation of ventricular events.

A class is created from similar QRS complexes with the same class characteristic. The QRS classes suggested by CardioDay are displayed separately. The assigned class characteristic is shown at top left:



Similar QRS classes on left of window

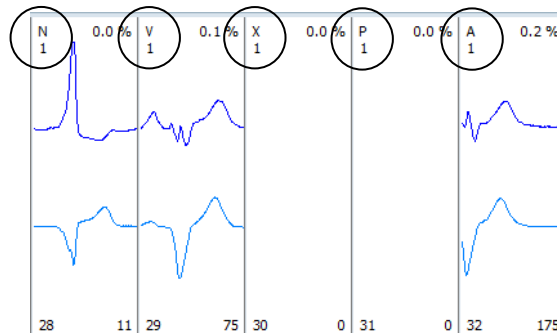
- **Normal (N)**
- **Ventricular (V)**
- **Aberrant (X)**
- **Paced, Stimulated (P)**
- **Artifact (A)**

Class characteristic	Description
Normal (N)	Supraventricular events are constructed from premature beats characterized as normal.
Ventricular (V)	Ventricular events are constructed from the QRS classes characterized as ventricular.
Aberrant (X)	A beat is classified as aberrant, either if the beat does not fulfill the criteria for the normal or ventricular beats, or if only one of both analyzed channels is broad or has a vector change. NOTE: If a beat from an aberrant class occurs close in time to a ventricular beat or to another aberrant beat, the aberrant beat is included in the evaluation of ventricular events.

Class characteristic	Description
Stimulated (P)	The stimulated QRS complexes are grouped in separate classes if pacemaker impulses have been displayed.
Artifact (A)	Artifacts are identified according to certain specific typical characteristics and are not included in the heart rate measurement.

Additional class characteristic "1"

All single beats that do not match any previous morphology and would actually need to form their own class are grouped in a separate class window that is labeled with the additional class characteristic "1".



Additional class characteristic 1

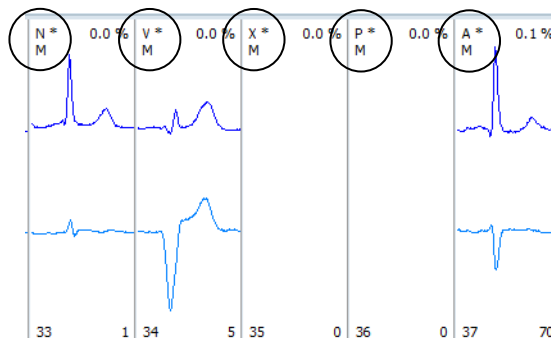
All automatically recognized single artifacts are also grouped in an additional class with the characteristic A **1**. You can reclassify the artifact classes on the left of the individual class window, but not the artifact classes with the characteristic "1".

Additional class characteristic "M"

You can also assign another characteristic to an individual displayed QRS complex.

These beats are sorted into the last five class windows according to their characteristic and labeled with the additional class characteristic "**M**" indicating manual editing.

You can repeatedly edit single beats labeled with the additional class characteristic "**M**", but not the entire class.



Additional class characteristics "*" and "M"

Navigate to the desired QRS complex using the scroll bar or left and right arrow keys.

You can alternatively select a particular QRS complex by double-clicking in the ECG context display near the R-peak.

Pressing **N**, **V**, **X**, **P**, or **A**, or clicking accordingly in the context menu, assigns the corresponding characteristic to the highlighted QRS complex.

Correction of the QRS class characteristics

NOTE:

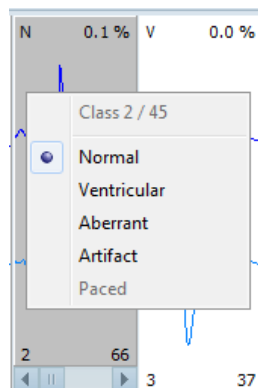
Since the predominant classes are shown first together with the number of beats within the class, if necessary you can rapidly correct the assigned characteristic for a large proportion of the QRS complexes, which quickly leads to practicable results. With a high-quality recording, well over 95 % of all QRS complexes are within the first eight QRS classes.

Correction of characteristic assigned to a whole class – the asterisk [*]

Select a QRS class by clicking with the mouse or using the **Enter** and **Backspace** keys. The shading of this QRS class window changes and the scroll bar is displayed at the lower edge if the QRS class contains several QRS complexes.

View approximately 10 QRS complexes of the selected QRS class with the **left** and **right** arrow keys or by clicking the scroll bar of the individual QRS class window.

Evaluate whether the assignment of the class characteristic (**N**, **V**, **X**, **P**, **A**) corresponds with your interpretation.



QRS class window with context menu for changing the QRS class characteristic

You can change the characteristic assigned to a QRS class in two different ways:

- To toggle through the QRS classifications **N**, **V**, **X**, **P**, or **A** in sequence, repeatedly press the **Delete** key.

- To correct the evaluation, right-click on the selected QRS class window to open a context menu and select the correct evaluation from the context menu. Distorted QRS classes with very low incidence can usually be easily designated as artifacts. These are then excluded from the subsequent event analysis.

If you manually change the characteristic assigned to a QRS class, this is indicated by an asterisk [*] to the right of the class characteristic.

X* 0.3%

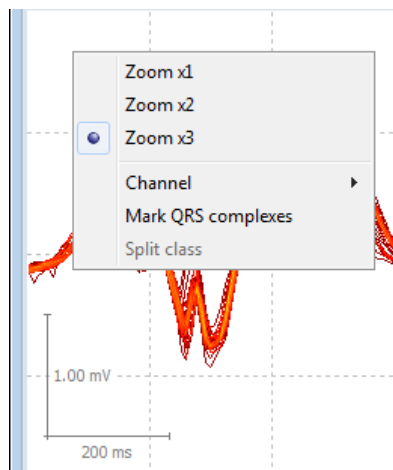
The asterisk disappears when you key through the class characteristics and return to the originally assigned characteristic without conducting a new event analysis. Otherwise, it is permanently displayed.

Quick-Scan for quick evaluation and correction, splitting a QRS Class

By checking the box labeled **Quick-Scan**, you can activate the superimposed display of all QRS complexes within a class.

The overlapping factor of QRS complexes of the same morphology is color coded. The channel being displayed is shown in the bottom left corner of the zoom window.

When the Quick-Scan function is activated, you can highlight a QRS complex that deviates from the general morphology with a left-click and rename the complex.



QRS-Zoom display with activated Quick-Scan function and context menu for zoom factor, channel selection, highlighting, and splitting QRS classes

Using the Quick-Scan function, you can split an existing QRS class into further classes on the basis of morphological differences.

NOTE:

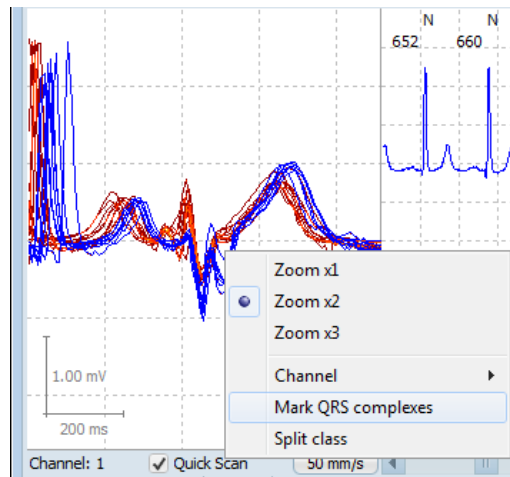
It is not possible to split classes if the class **Overview** box is checked.



Class overview activation checkbox

1. Select the amplitude in the QRS zoom window with the mouse such that the QRS complexes to output into a new class lie below this position.
2. At this point, right-click to open the context menu and select the **Mark QRS complexes** option.

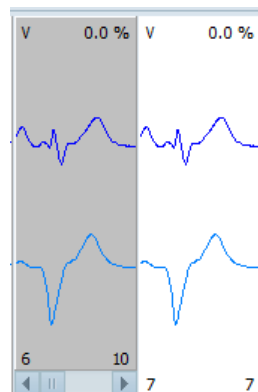
All the QRS complexes with a voltage value below the mouse position will be marked.



Quick-Scan function of the QRS-Zoom display with context menu for the selection and splitting of QRS classes, lower voltage value range highlighted

3. If necessary, repeat steps 1 and 2 to select different voltage values.
4. Once you have selected all the complexes to output to a new class, right-click to open the context menu and select **Split class**.

The new QRS class will appear to the right of the original class.



Two QRS classes generated by splitting

8

Evaluation and correction on the Events tab

The **Events** tab displays the different arrhythmias that were detected during the recording duration. Their detection and medical evaluation can be of high diagnostic significance.

Like the QRS complexes, CardioDay automatically classifies events. The software displays the most significant events first. Similar to the QRS classification, you must also evaluate and, if necessary, correct the event classification.

Assigned keys on Events tab

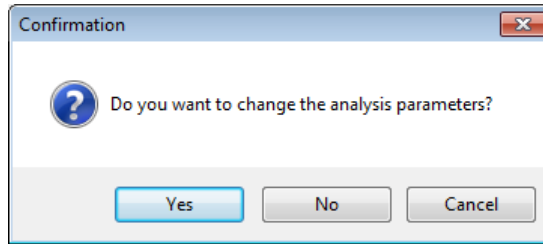
The following shortcut keys are available on the **Events** tab:

Shortcut key	Function
Enter	moves to next event
Del	deletes marked event
Arrow right/down	switches to next event line
Arrow left/up	switches to previous event line
Insert	reinserts a deleted event—Note: only possible if no event analysis has been carried out
Backspace	moves to previous event
Ctrl+S	saves ECG strip to the report

Analysis parameters and event classification

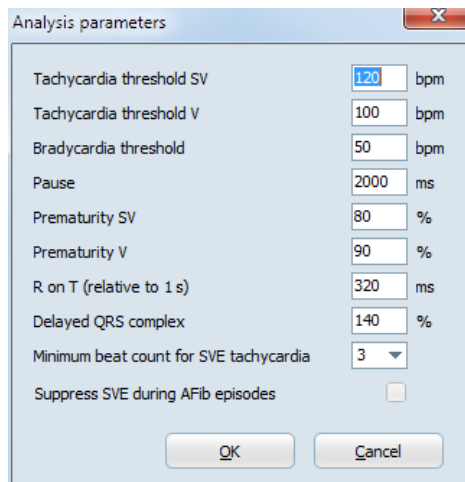
During downloading of the recording, CardioDay carried out the first event analysis. After the evaluation, if you decide on a different QRS classification, a new **Event analysis** is carried out.

The **Analysis parameters** are threshold values for the event analysis. If these values are exceeded by heartbeats, they are interpreted as events or special circumstances.



Confirm changing of analysis parameters

When selecting **Reanalyze events...** from the **Extras** menu, you are asked whether you want to change the analysis parameters. When answering **Yes**, the **Analysis parameters** window opens.



Analysis parameters

An event analysis is carried out after every modification of the analysis parameters.

In addition to thresholds for bradycardia and tachycardia, you can set the thresholds for **R-R Pause**, **Prematurity SV** and **Prematurity V**, **R-on-T**, and for **Delayed QRS complex**. Also, you can select **Suppress SVE during AFib episodes**.

The **R-on-T** value, which must be set in milliseconds, refers to an RR interval of 1 s. In this time interval, **R-on-T** is detected. The **RR interval** reference value is automatically adjusted to the current heart rate.

CardioDay is able to classify the following events:

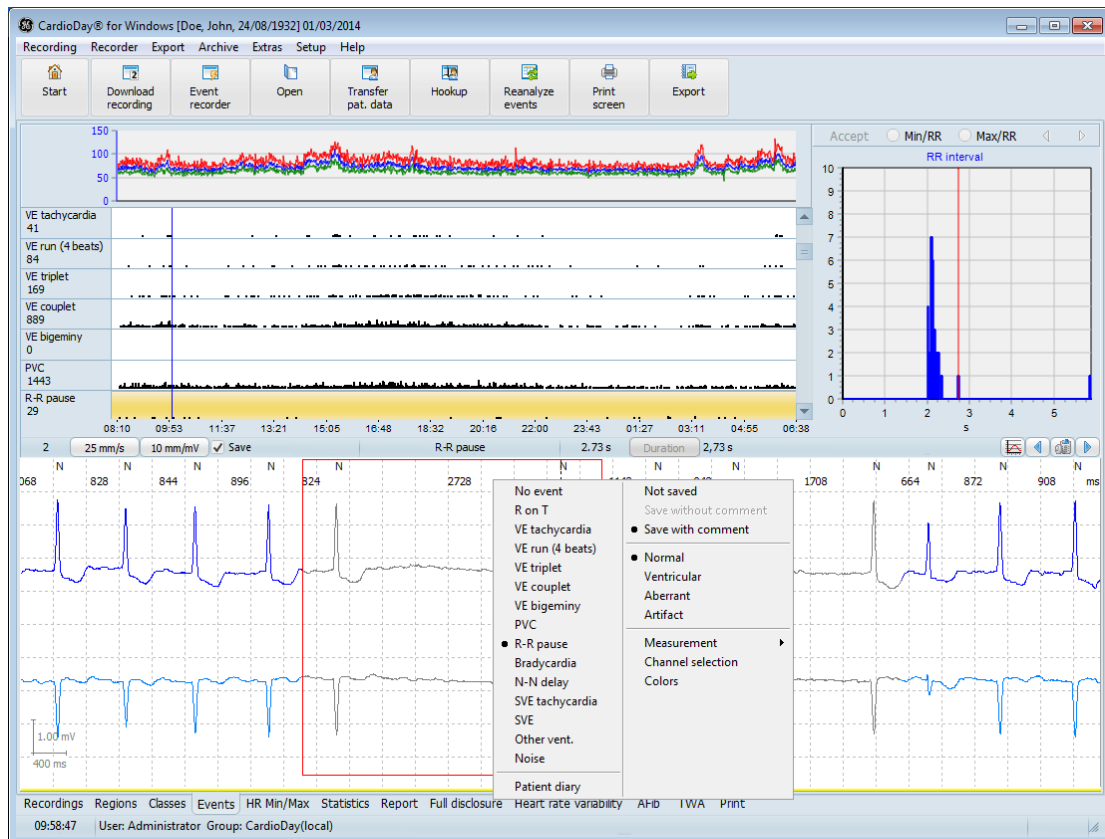
Event	Description
<i>R on T</i>	Ventricular QRS complex occurring during the vulnerable phase of the chamber repolarization. QRS complexes with the characteristic “V” for “ventricular”.
<i>VE tachycardia</i>	Ventricular tachycardia, at least five QRS complexes—with the characteristic “V” or “X”, if the heart rate is higher than that set in the analysis parameters.
<i>VE run (4 beats)</i>	Four QRS complexes—with the characteristics “V” or “X” with the heart rate higher or the RR interval shorter than that set in the analysis parameters.
<i>VE Triplet</i>	Three consecutive <i>PVCs</i> —with the RR interval shorter than that set in the analysis parameters.
<i>VE Couplet</i>	Two <i>PVCs</i> at the most within the time set for PVC in the analysis parameters.
<i>VE Bigeminy</i>	At least three alternations between normal beat and PVC consequently.
<i>PVC</i>	Ventricular extrasystole, i.e., a spontaneous QRS complex which is independent of the P wave with the RR interval shorter than that set as the <i>Prematurity V</i> analysis parameter. (CardioDay uses an average value calculated from previous RR intervals as a reference interval.)
<i>Other vent.</i>	Ventricular beats that do not meet the prematurity criteria (Prematurity V), which the user can set in the event analysis parameters.
<i>R-R pause</i>	RR interval longer than or equal to the value set as pause rhythm parameter in milliseconds.
<i>Bradycardia</i>	Heart rate of at least four beats below the value set as <i>Bradycardia threshold</i> analysis parameter.
<i>N-N delay</i>	Atypical and sudden extension of the RR interval—with the RR interval longer than the set <i>Delayed QRS complex</i> analysis parameter. (CardioDay uses an average value calculated from previous RR intervals as a reference interval.)
<i>SVE tachycardia</i>	Supraventricular tachycardia, constant fast heart rate—with the heart rate exceeding the value set as <i>Tachycardia threshold</i> analysis by more than three beats and the event beginning with a SVE.
<i>SVE</i>	Supraventricular extrasystole—with the RR interval shorter than that set as the <i>Prematurity SV</i> analysis. (CardioDay uses an average value calculated from previous RR intervals as reference interval.)
<i>Diary</i>	“Diary” includes two kinds of events: • Patient-generated events each corresponding to the times when the button on the recorder was pressed. • User-generated diary events (see chapter “Adding a Patient diary event” on page 79.

Event	Description
Noise	Sequence of several artifacts in succession in a single channel. Occurs only if Noise detection is enabled. Additional Noise events are marked if one channel is saturated, e.g., if an electrode is loose or disconnected. This is independent of the automatic Noise detection .
Saved	Events or ECG sequences selected automatically or by the user for saving with the report or separately. NOTE: These ECG sequences are processed similarly to the cardiological events automatically detected during analysis and are therefore included in this list.

Evaluation and correction of the event classification – overview

Evaluate the assignment of QRS complexes to an event class carried out by CardioDay and correct if necessary:

- Select an event class by clicking with the mouse on the corresponding line. By pressing **Enter**, the most important event is immediately marked and indicated in the respective event line.
- Press **Enter** to confirm an event classification and move onto the next event.
- Press **Delete** to disagree with an event classification. The event is deleted and the next event is displayed.
- To edit a QRS complex or event, right-click in the ECG context display to open the context menu and select the appropriate event classification.



Events tab with context menu for reclassification

- Having finished editing an event class, select a new event class using the corresponding arrow key or left-clicking.
- Mark interesting events for subsequent printing by first right-clicking in the ECG context display to open the context menu and then clicking **Save w/ comment** or **Save w/o comment**.
 - When clicking on **Save w/ comment**, a window opens allowing you to enter a comment for the current event. The comment can be up to 40 characters long.
 - When clicking **Save w/o. comment** or pressing **Ctrl+S**, the event is marked for printing without comment.
 - If you select **No save**, an event automatically marked for printing will not be printed.

The explanations of the different CardioDay printouts on paper or in one of several file formats can be found in the section “[The Print tab](#)” on page 153.

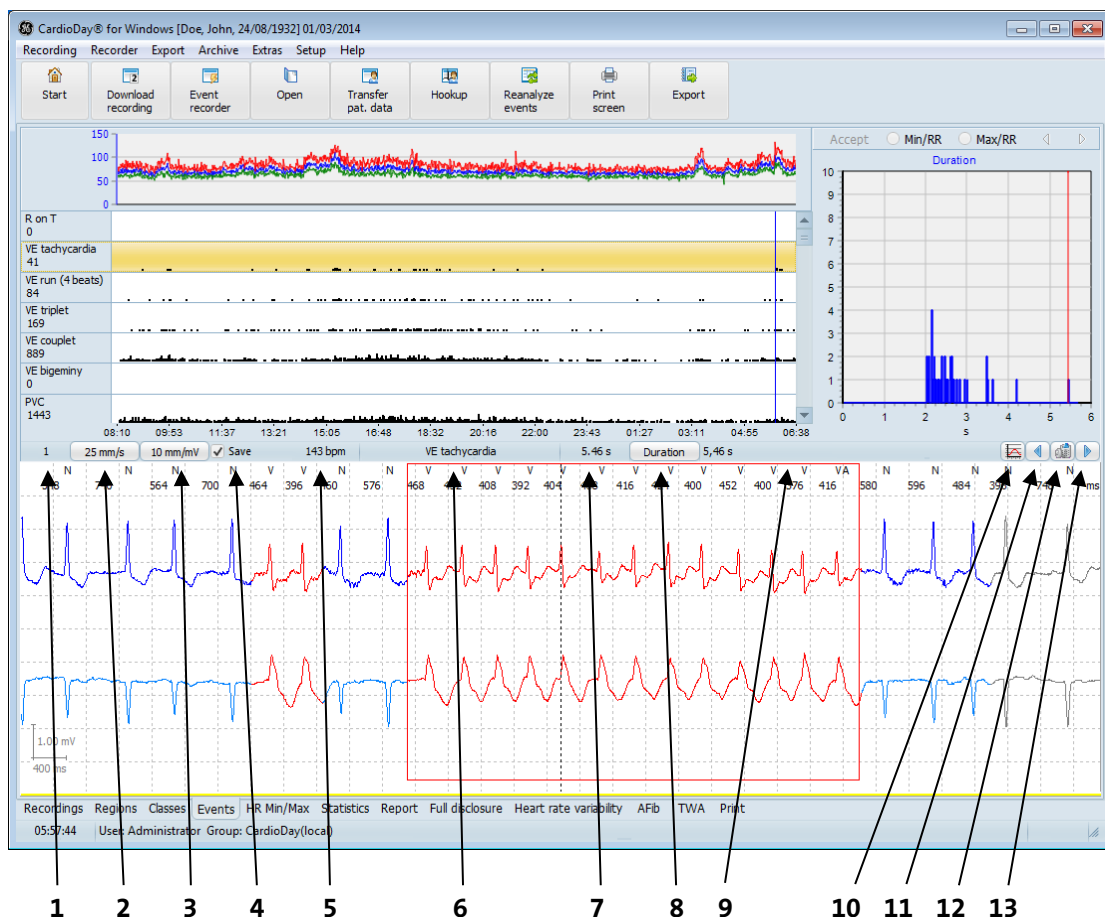
Repeat these steps for all event classes of interest. Exit the event classification by selecting a different working step tab at the bottom of the screen.

Screen layout and operation of the Events tab

Each event class is summarized in a line in the upper half of the **Events** workspace. Under the designation of each event class, the number of the events found in the corresponding class is displayed.

- To scroll forwards through the individual events, press **Enter**.
- To scroll backwards through the individual events, press **Backspace**.
- To switch between event classes, use the **up/down** arrow keys or click with the mouse in the desired event class.
- To display a particular event, click on a point in the event class line.
- To delete the active event, press **Delete**.
- To restore a deleted event, press **Insert**.

In the **RR Min/Max** window you may, if necessary, correct the shortest and longest RR intervals.



Workspace of the events tab

In the center row of the workspace, the following status information is available:

1. Sequential number of the event.
2. Display size of the time axis.
Each mouse click switches through 6.25, 12.5, 25, 50, and 100 mm/s.
3. Display size of the amplitude axis.
Each mouse click switches between 5 mm/mV, 10 mm/mV, 20 mm/mV, 40 mm/mV.
4. Indication of whether the current event has been saved for printing.
Toggle by mouse click.
5. Current average heart rate.
6. Designation of the current event.
7. Length of the VE Tachycardia or SVE Tachycardia episode.
8. Button for the sort criterion, which—together with the diagram on the top right of the window—changes according to the currently marked event class.

The sort criterion can be switched for VE Tachycardia, SVE Tachycardia and Brady between Duration [s] of episode and heart rate [bpm].

The sort criterion can be switched for PVC between the criteria “Prematurity” [%] and “Turbulence Slope” [HRT] (for more detailed information refer to [“Listing of events in the separate event classes”](#) on page 76 and to [“Heart Rate Turbulence \[HRT\]”](#) on page 80.
9. Display of comments automatically generated by CardioDay for the two most significant events of each event class.

You can also enter comments for any event by right-clicking it and selecting **Save w. Comment**, which opens the comment window.
10. Button to open and close the **RR Min/Max window**, where the shortest and longest RR intervals are set.
11. Button for mouse navigation to preceding event, corresponds to **Backspace** key.
12. Button to delete event, corresponds to **Delete** key.
13. Button for mouse navigation to following event, corresponds to **Enter** key.

Listing of events in the separate event classes

Event	Parameter/Sorting criterion	Unit
<i>R-on-T</i>	Duration	s
<i>VE tachycardia</i>	Duration	s
<i>VE tachycardia2*</i>	HR	bpm
<i>VE run (4 beats)</i>	HR	bpm
<i>VE Triplet</i>	HR	bpm
<i>VE Couplet</i>	HR	bpm
<i>VE Bigeminy</i>	Duration	s
<i>PVC</i>	Prematurity**	%
<i>PVC2</i>	HRT**	TS
<i>Other vent.</i>	HR	bpm
<i>R-R pause</i>	Duration	s
<i>Brady</i>	Duration	s
<i>Brady2*</i>	HR	bpm
<i>N-N delay</i>	Duration	s
<i>SVE tachycardia</i>	Duration	s
<i>SVE tachycardia2*</i>	HR	bpm
<i>SVE</i>	Prematurity	%

Within the event classes, the events are listed by default hierarchically in order of importance.

You can impose a chronological ordering of all event classes by clicking twice on an event line that has already been selected. To switch back to the hierarchical order, you need to change the event line and choose the desired event line again.

The content of the diagram at the top right on the **Events** tab changes according to the type of event and the sorting within the respective event line. The sort criteria and the units of the x-axis can be taken from the opposite table. (The frequency is always plotted on the y-axis.)

* For the events Brady, SVE Tachycardia, and VE Tachycardia, you can toggle the event criterion between **Duration** [s] and Heart rate [HR] (marked in the table by a "2" behind the event name, e.g., **Brady2**) by clicking the field for the sort criteria in the status line of the **Events** screen. This also changes the units from **s** to **bpm**.

** When using the module for the evaluation of **Heart Rate Turbulence** [HRT], you can toggle the **PVC** event line from **Prematurity** to **HRT**.

QRS complex and switching tabs

If you are in the **Events**, **HR-Min/Max**, **Statistics**, or **Full disclosure** tabs and you double-click the QRS complex, CardioDay switches into the **Classes** tab and shows the complex in its class. Most tabs are linked to each other via the current QRS complex. After selecting an event, the QRS complex that belongs to it remains active, even if you switch to the **Classes** or **Full disclosure** tab.

When switching from the **Classes** tab to the **Events** tab, the program jumps back to the last event viewed (or to the first event, if no event has been viewed yet).

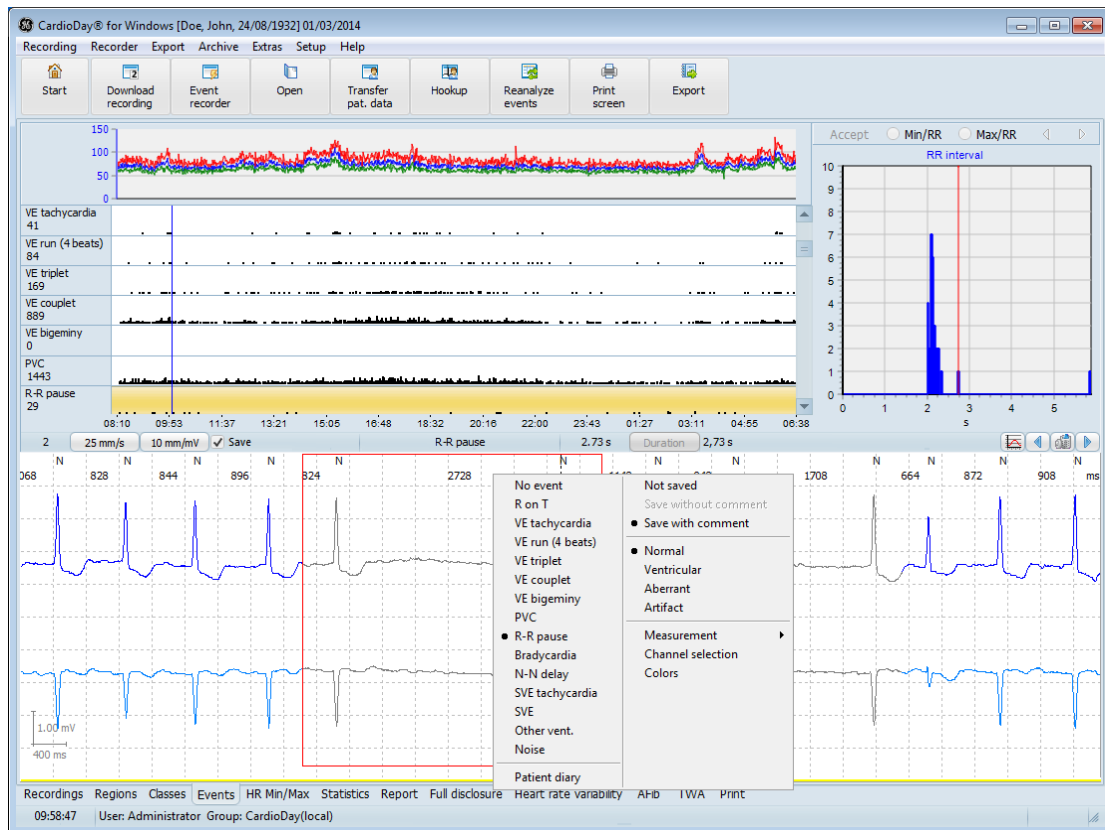
Because the statistical values are displayed in terms of minutes, these are not linked to individual QRS complexes but to the period being represented.

Reclassification of events using the + and – keys

You can reclassify all events identified by CardioDay using the context menu of the event classes, which is accessed using the right mouse button.

Event classifications can also be changed quickly within the event hierarchy using the + and – keys on the numeric keypad: If, e.g., an event is marked **R-R pause**, you can change it to **PVC** by pressing the + button.

- + changes the event to the next-highest event class in the hierarchy.
- – changes the event to the next-lowest event class in the hierarchy.



Events tab with event classes context menu

Designating an event to be an artifact

If an event has been incorrectly identified due to the currently active QRS complex only, you can designate this one QRS complex to be an artifact by pressing **Ctrl+a**.

To relabel a non-active QRS, switch to the **Classes** tab.

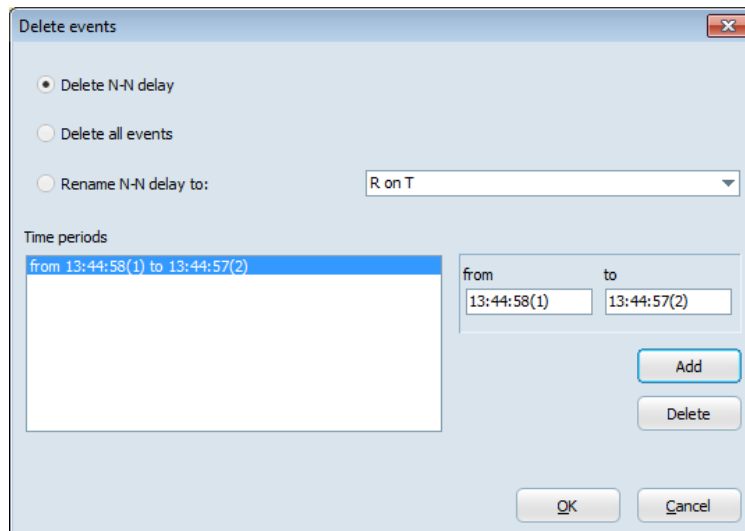
RR interval or heart rate in the ECG context display

The ECG context display shows, above or below the class characteristic of the individual QRS complex, either the RR interval in milliseconds (ms) or the heart rate in beats per minute (bpm).

To toggle between the two values, place the cursor over one of the numbers and double-click.

Deleting and renaming event classes

Click on one of the event classes on the left-hand side of the event histogram designation column to activate the menu that allows you to delete or rename the currently active event class or to delete all events.



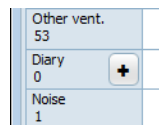
Events tab, erasing events

When doing this, it is important to enter the period. After the entry, click **Add** to enter the period into the list.

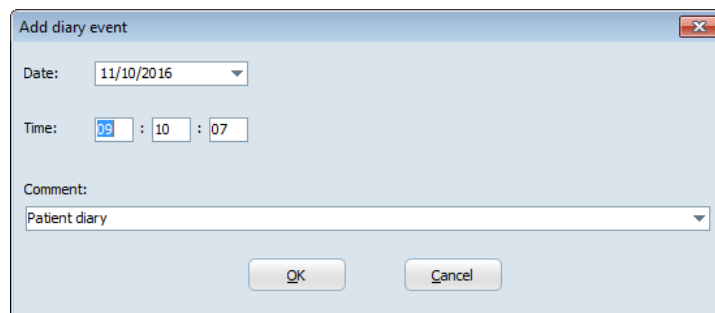
You can also **Rename** selected events.

Adding a Patient diary event

1. To add a patient diary event, click on the plus icon in the Diary line.



2. The **Patient diary** window opens where you can enter the desired time and the diary comment.



Window for entering the time of a Patient diary event

3. If you confirm by clicking **OK**, the patient diary entry will be displayed in the **Diary** line.

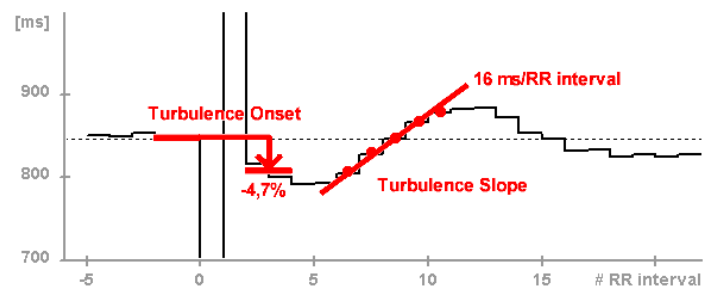
Heart Rate Turbulence [HRT]

If you have marked the line with the PVC events on the **Events** tab, you can switch between the display by prematurity [%] and the display of any Heart Rate Turbulences [HRT] by clicking in the status line on the field marked either with “%” or “HRT”. The HRT diagram is displayed at the top right of the window and toggles accordingly.



Events tab, HRT evaluation

Quantifying of HRT by Turbulence Onset and Slope



Turbulence Onset and Slope in the RR-diagram

For quantifying of HRT, two parameters are calculated:

- Turbulence Onset (**TO**)
- Turbulence Slope (**TS**)

Turbulence Onset (**TO**) is the percentage of difference between the heart rate immediately following PVC and the heart rate immediately preceding PVC. It is calculated using the following equation:

$$TO = ((RR_1 + RR_2) - (RR_{-2} + RR_{-1})) / (RR_{-2} + RR_{-1}) * 100$$

In the equation, RR-2 and RR-1 are the first two normal intervals preceding the PVC, and RR1 and RR2 are the first two normal intervals following the PVC. Initially, **TO** is determined for each individual PVC, followed by the determination of the average value of all individual measurements. Positive values for Turbulence Onset indicate deceleration; negative values indicate acceleration of the sinus rhythm.

The Turbulence Slope (**TS**) corresponds to the steepest slope of the linear regression line for each sequence of five consecutive normal intervals in the local tachogram. The Turbulence Slope calculations are based on the averaged tachogram and expressed in ms per RR interval.

The algorithm for HRT quantification can only deliver usable results if the triggering event was a true PVC (and not an artifact, T wave, or similar). In addition, it must be ensured that the sinus rhythm immediately preceding and following the PVC is free from arrhythmia, artifacts, and false classifications. In order to fulfill these requirements, we use filters that exclude RR intervals with the following characteristics from the HRT calculation:

- < 300 ms
- > 2000 ms
- > 200 ms difference to the preceding sinus interval
- > 20 % difference to the reference interval (mean of the last 5 sinus intervals)

In addition, we limit the HRT calculations to PVCs with a minimum prematurity of 20 % and a post-extrasystole interval that is at least 20 % longer than the normal interval.

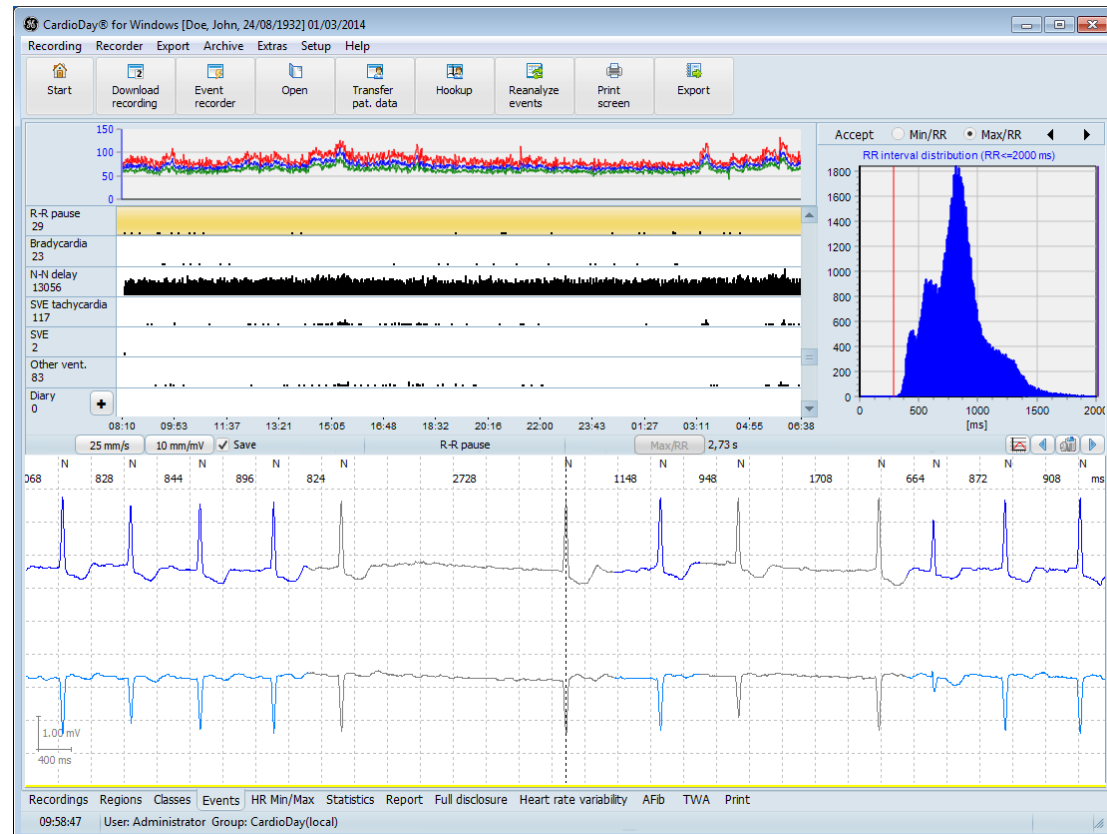
Background information / Relevance

HRT—Heart Rate Turbulence—is the physiological, bi-phasic response of the sinus node to premature ventricular contractions. It consists of a short initial acceleration followed by a deceleration of the heart rate. HRT can be quantified by two numerical parameters, namely the Turbulence Onset and the Turbulence Slope.

The underlying mechanisms of HRT have not been fully identified. HRT is most probably an autonomous baroreflex. The premature ventricular contraction causes a brief disturbance of the arterial blood pressure (low amplitude of the premature beat, high amplitude of the ensuing normal beat). When the autonomic control system is intact, this fleeting change is registered immediately with an instantaneous response in the form of HRT. If the autonomic control system is impaired, this reaction is either weakened or entirely missing.

Setting the minimum and maximum RR intervals

On the **Events** tab you can additionally evaluate and, if necessary, correct the minimum and maximum RR intervals. The set values can be displayed in the report and are used for the calculation of the average heart rate.



Events tab > RR Min/Max window

Procedure to set the maximum RR interval:

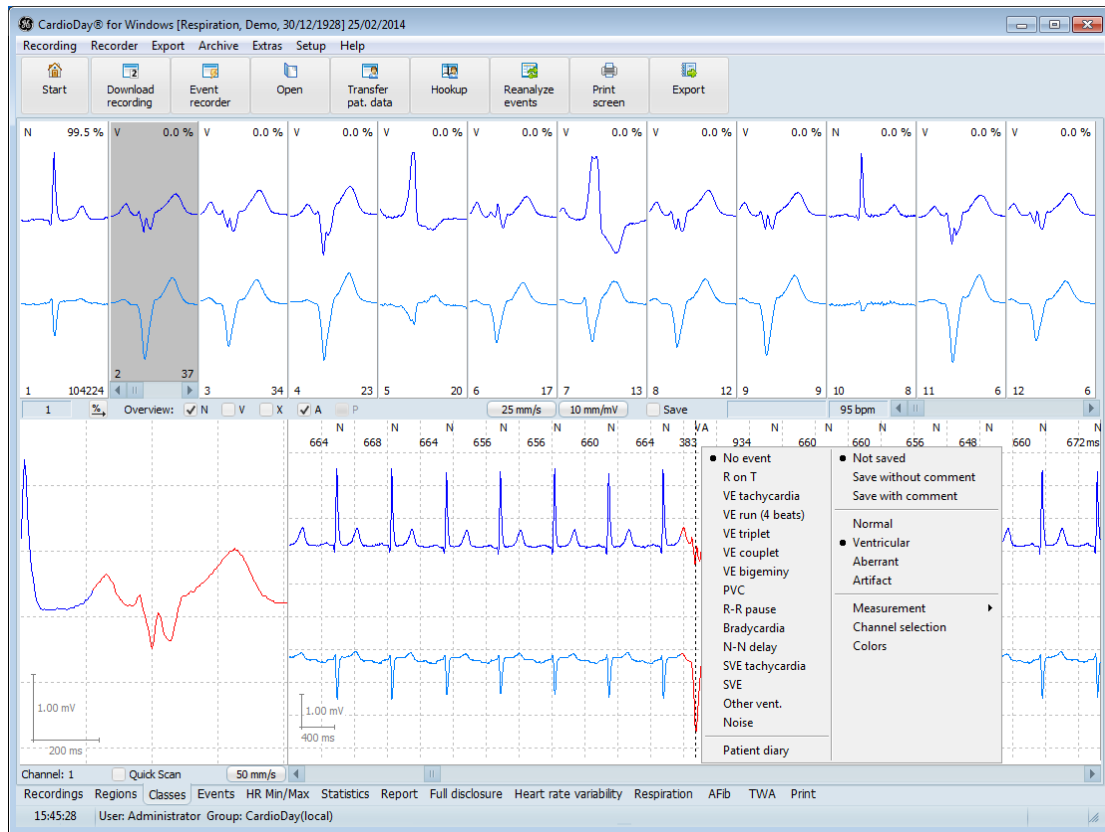
1. Click the **Max/RR** button in the **RR Min/Max** window.
2. Press **Delete** or click the left arrow button until the longest RR interval is displayed on the example stripe.
3. Click the **Accept** button or press **Enter** to accept the value.

Procedure to set the minimum RR interval:

1. Click the **Min/RR** button in the **RR Min/Max** window.
2. Press **Delete** or click the right arrow button until the shortest RR interval is displayed on the example stripe.
3. Click the **Accept** button or press **Enter** to accept the value.

Editing events on the Classes tab

To modify the assignment of an active QRS complex to an event class, right-click to open the event classes menu and click on the event class to be assigned. To declare an individual QRS complex to be an artifact, press the **A** key.



ECG context of the selected QRS complex with context menu

9

The HR Min/Max tab

The **HR Min/Max** tab gives you an overview of the heart rate trend.

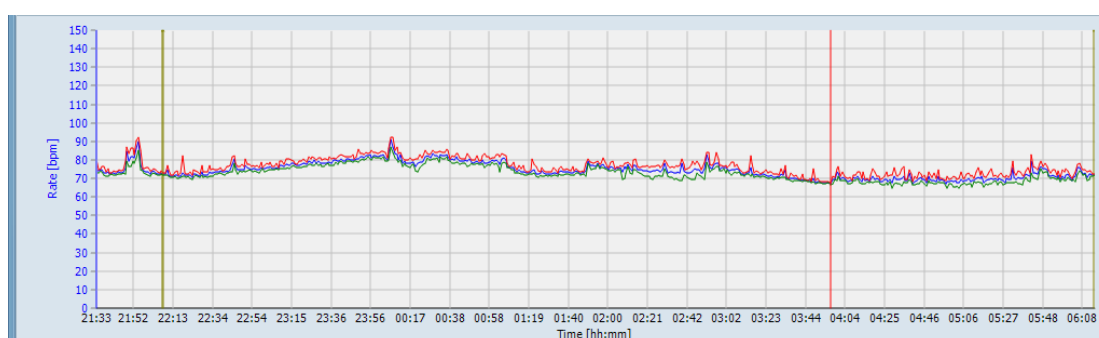
It also displays the time and value of the patient's minimum and maximum heart rate during the recording period. You must review the values suggested by CardioDay and correct them if necessary.

Press **Delete** to disagree with and delete the suggested minimum or maximum heart rate value. Press **Enter** to agree with the minimum or maximum heart rate value.

Display of “manual” events, i.e., events triggered at the recorder

In addition to the histogram of the heart rate, this tab displays events that were marked at the recorder when the event button was pushed.

The time of a manually triggered event is displayed as a green vertical line (as default).



Display of a manually set event marker

The HR Min/Max tab

Evaluation and correction of the extreme heart rate values

Select the **HR Min/Max** tab in order to see the heart rate trend.

The heart rate is calculated from RR intervals over one minute.

If a QRS complex was included in the heart rate calculation, a trigger mark is displayed above it.



HR Min/Max tab

Adding an undetected QRS complex manually

If there is no marking over any QRS complexes (e.g., in the event of amplitudes being too low or having too much interference), they have not been included in the heart rate calculations.

You can add a QRS complex manually if it was not correctly triggered by the system:

1. Double-click the beat to return to the **Classes** tab.
2. Right-click the QRS complex in which the trigger-mark is missing. A context menu will open.
3. Select the **Insert QRS complex** option.
4. Switch back to the **HR Min/Max** tab to continue with your evaluation.

Accepting or changing extreme values automatically calculated

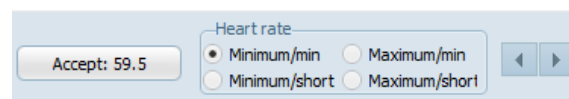
1. Use the **Page up** and **Page down** keys to browse forwards and backwards through the heart rate trend curve.

The blue line in the middle represents the heart rate's average values per minute.

The top red line represents the maximum value of the heart rate per minute. In order to reduce interference, the moving average of the individual values is taken over 10 beats.

The bottom green line represents the minimum values per minute, which have been averaged in the same way.

2. Use the tool to the right of the usual toolbar icons to find and accept the minimum and maximum heart rates.



Tool for finding and accepting the minimum and maximum heart rate

NOTE:

Clicking **Minimum/min** or **Maximum/min** in the first line, the minimum or maximum heart rate averaged over the respective minute of the recording is found.

Clicking **Minimum/short** or **Maximum/short** in the second line, the minimum or maximum heart rate will be averaged over a shorter period, approximately 10 RR intervals. This results in a lower minimum and a higher maximum heart rate for the respective minute of the recording.

3. Select the desired heart rate filter by clicking **Minimum/min** or **Maximum/min**, **Minimum/short** or **Maximum/short**.

As a result, in the graph of the heart rate trend, the red line is positioned on the extreme heart rate value determined by CardioDay.

The corresponding extreme value is displayed on the **Accept** button on the left-hand side.

4. Click the **Accept** button or press the **Enter** key to include the extreme value currently displayed in your report.

The next point is selected automatically.

Example: Due to undetected beats or artifacts misinterpreted as real beats, it is possible that the software incorrectly determines extreme heart rate values.

5. Review the determined extreme values.
6. If necessary, select regions with a better detection rate by clicking on the arrow buttons in the toolbar or pressing the **Delete** key to move the marking to the next-highest or next-lowest value.
7. Include the value finally selected in your report by clicking on the **Accept** button or pressing **Enter**.

Zooming in and out

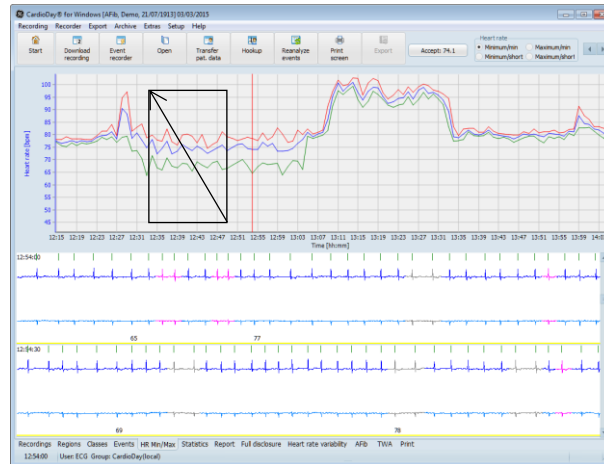
You can easily change the period shown and the magnification of the heart rate display (zoom) by using the mouse. The zoom function is also available in all displays of the **Statistics** tab.

- Hold the left mouse button and drag the desired region from the top left to the bottom right.



The marked region is magnified to the entire width of the window. The smaller you drag the rectangle, the larger the magnification of the data will be.

- To reverse the magnified area back to its original size, hold the left mouse button and drag from the bottom right to the top left.



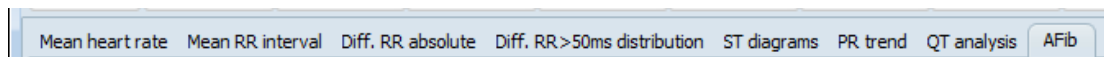
When doing this, the mouse pointer can be at any position of the magnified area and only needs to be dragged a short distance to the top left.

10

The Statistics tab

Select the **Statistics** tab to evaluate the statistics calculated by CardioDay.

The sub-tabs at the upper edge of the workspace display the available statistics. The statistics always relate to the entire recording time.



Sub-tabs of the Statistics tab

The following statistics can be displayed in sub-tabs, which will be discussed in separate sections following:

- **Mean heart rate**
- **Mean RR interval**
- **Diff. RR absolute**
- **Diff RR > 50 ms distribution**
- **ST diagrams**
- **PR trend**
- **QT analysis**
- **AFib**

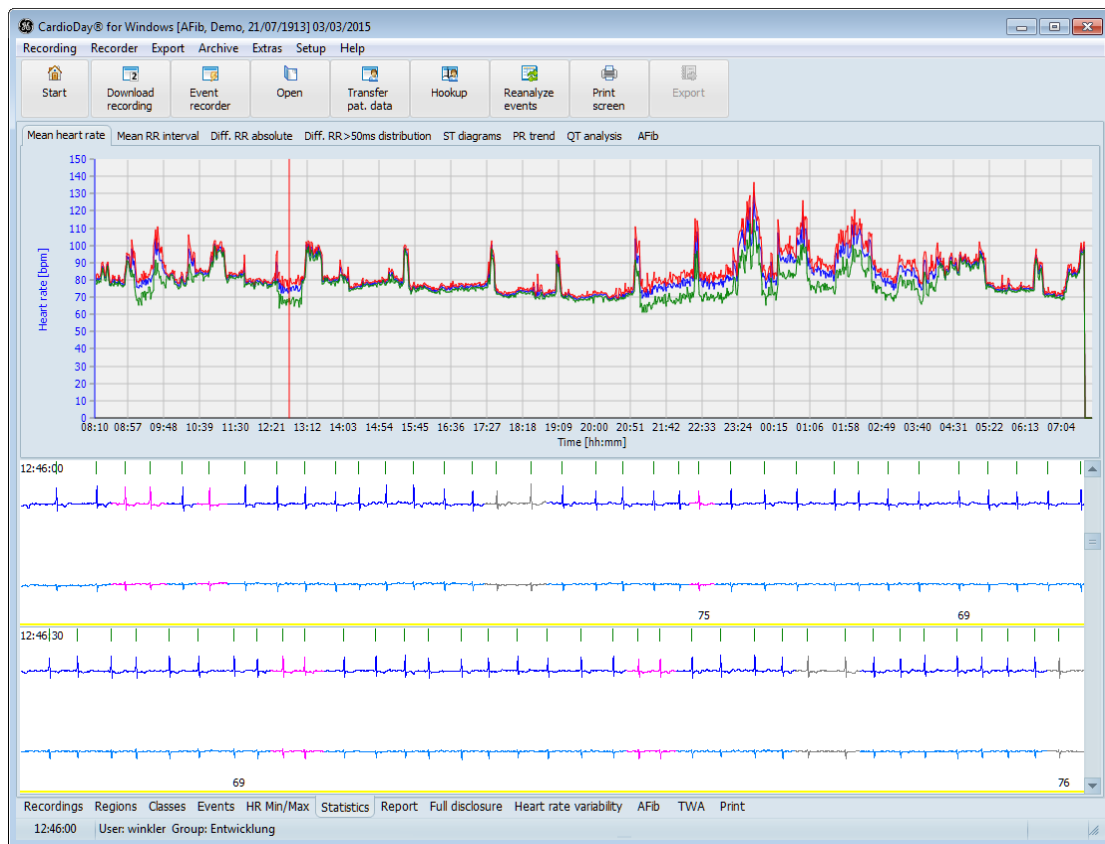
Mean heart rate and mean RR interval

The average heart rate, which is derived from the RR intervals over one minute, is graphically displayed over the measuring period (middle blue line).

Additionally, the maximum (upper red line) and minimum (lower green line) heart rates are displayed. Those values are taken from the heart rate as a moving average over 10 beats.

The Statistics tab

The HR trend calculated over one minute intervals is displayed in the background of most statistical graphs to aid their interpretation. This HR trend can be deactivated in **Setup > Other options > Miscellaneous**.



Statistics tab > Mean heart rate

The mean RR interval is the reciprocal value of the mean heart rate.



Statistics tab > Mean RR interval

Diff. RR absolute

In contrast to the **Diff. RR > 50 ms distribution**, the **Diff. RR absolute** is used to provide a more quantitative description of the mean deviations between consecutive RR intervals.

Statistical calculation

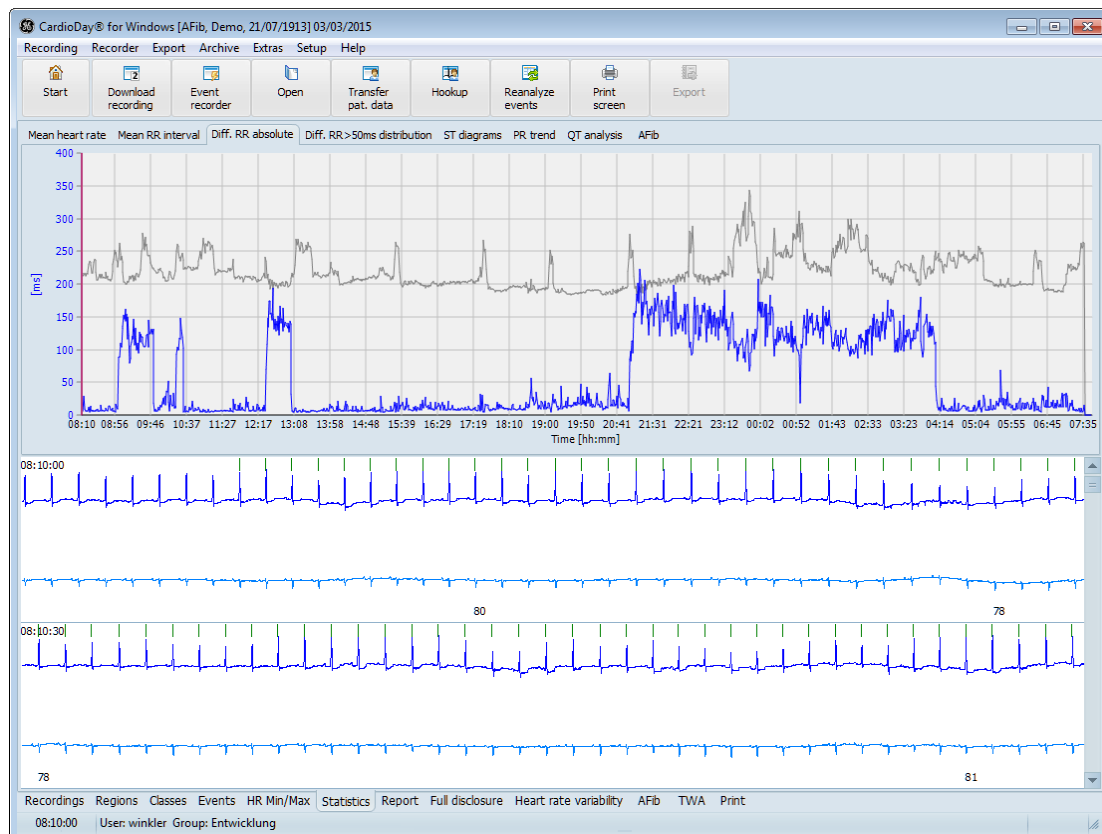
The **Diff. RR absolute** shows the mean values of the absolute values of the differences between the RR intervals of consecutive beats over one minute.

$$\sum_i^N \frac{|RR_i - RR_{i-1}|}{N}$$

Background information / Relevance

The value of the **Diff. RR absolute** increases with strong arrhythmia.

The sinus rhythm shows higher values during night hours than during the day, which can be explained by the fact that the heart is primarily controlled vagally during sleep resulting in lower heart rates, i.e., large RR intervals and distinct sinus arrhythmia (i.e., large mean deviations). In the presence of constant heart rates, this value is lower.



Statistics tab > Diff. Y-T distribution

Diff. RR > 50 ms distribution

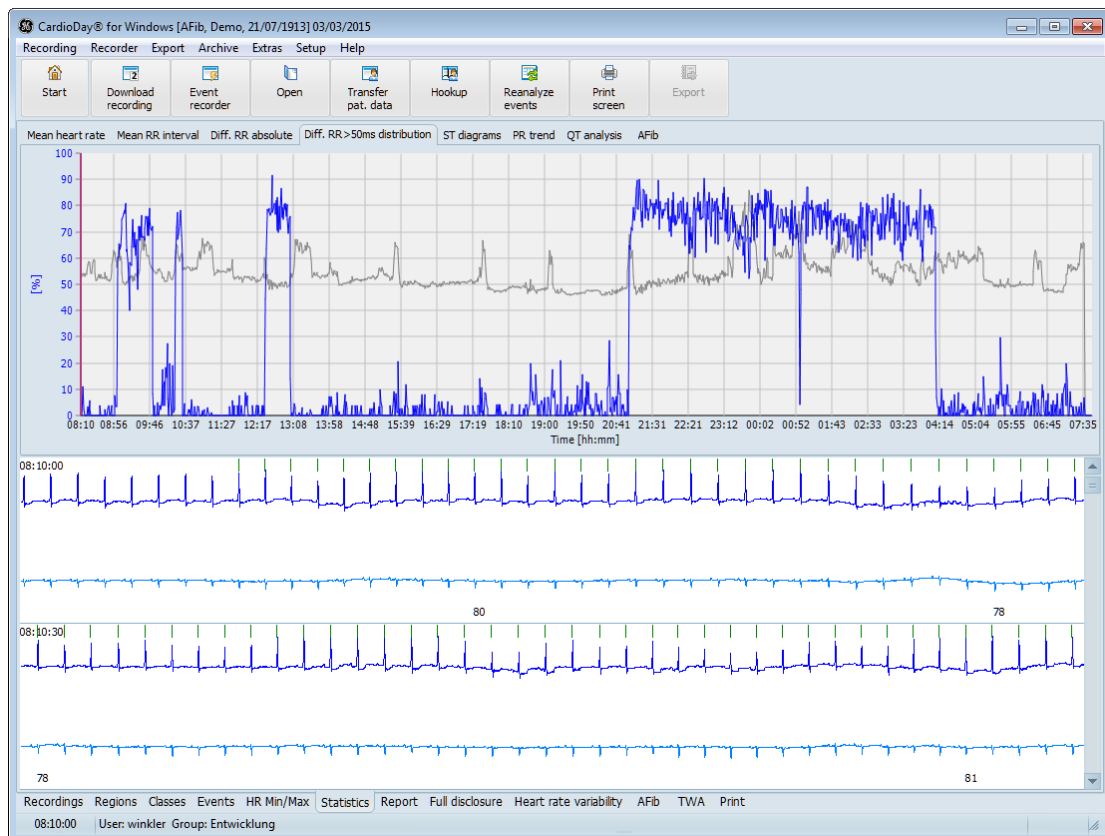
The **Diff. RR>50 ms distribution** tab shows the percentage of the RR intervals with a difference in length of over 50 ms in relation to the previous RR interval.

Statistical calculation

The **Diff. RR>50 ms distribution** is displayed as a percentage of all RR intervals in the minute observed.

$$\frac{\text{Number}((RR_i - RR_{i-1}) > 50\text{ms})}{\text{Number}(RR_i)} \quad 100\%$$

These values are displayed over the measuring period.



Diff RR > 50 ms distribution

Background information / Relevance

In the sinus rhythm, the values are usually under 30%; in the presence of atrial fibrillation, they are usually over 70% because the transmission of atrial fibrillation to the main chambers is extremely irregular and the deviations between successive RR intervals are therefore often greater than 50 ms.

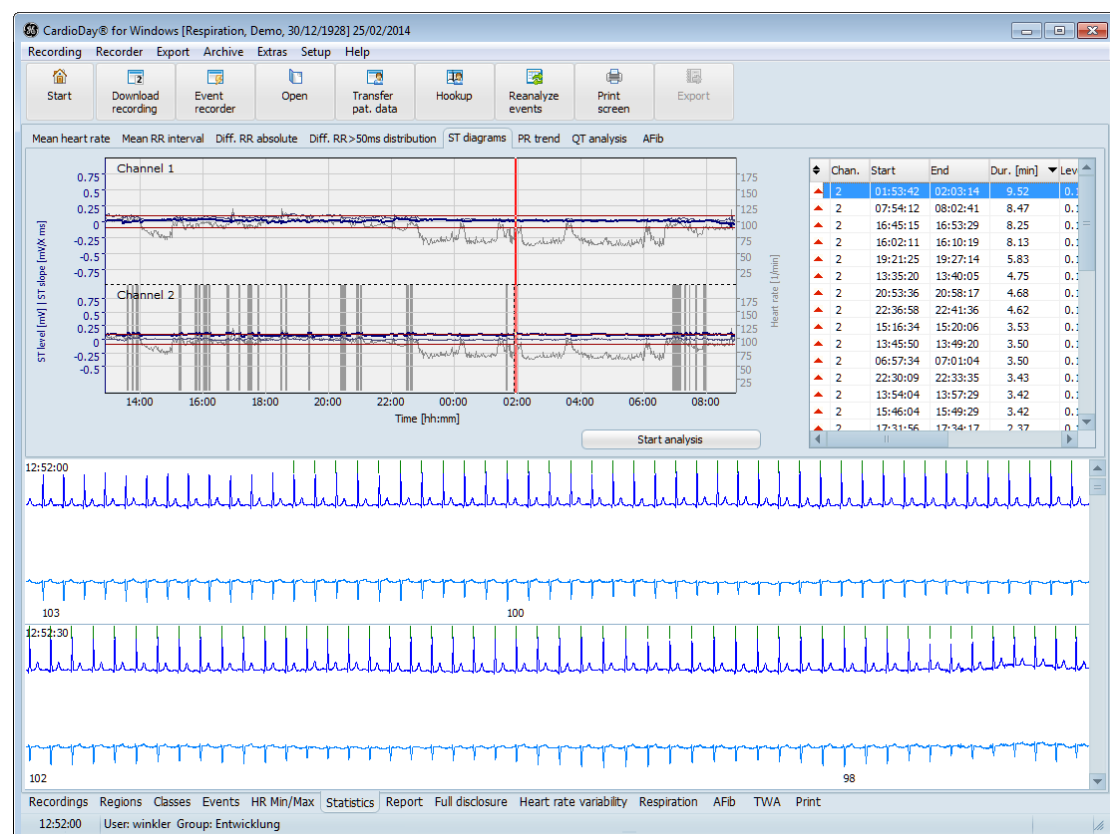
If the ordinate value of the diagram suddenly increases to 70%, there is a high probability of intermittent atrial fibrillation or a distinct arrhythmia in the main chambers of the heart caused by something else, e.g., a strong supraventricular extrasystole, if a large number of artifacts on the recording do not offer an alternative explanation. Intermittent atrial fibrillation can be easily identified on the diagram. However, we urge you to check the relevant point in time of the original ECG recording before making any decisions. Values over 70% can also be generated by strong respiratory sinus arrhythmia, as found, for example, during night sleep.

ST diagrams, evaluation and correction of the extreme values of the ST deviation

The results of the ST analysis are used in particular to identify silent ischemia.

As it is possible that the software determines false positive regions of ST deviation, e.g., when the patient changes position, it is recommended all regions be manually evaluated.

The **ST diagrams** tab shows the ST level (deviation) and ST slope over the observation period.



Statistics tab > ST diagrams

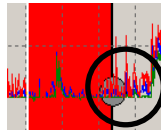
- The red lines display the limits of the ST deviation in mV. They are fixed at ± 0.1 mV. A region is detected when one of the limits is exceeded for more than 30 seconds.
The voltage level prior to the QRS complex is used as the reference voltage.
- The bold blue line displays the ST deviations.
The ST deviation is calculated as the average voltage in a 30 ms window beginning 50 ms after the J point.

- The thin blue line displays the ST slope.

ST slope is defined as the slope of the regression line of the ECG signal in a 60 ms window beginning 20 ms after the J point.

On the **ST diagrams** tab, you can change the zoom of the display and mark new regions of relevant ST deviations:

- To zoom, hold the left mouse button and drag the mouse pointer diagonally over the histogram.
- To mark a new region of relevant ST deviations, hold the left mouse button and drag the mouse pointer parallel to the time axis over the histogram.



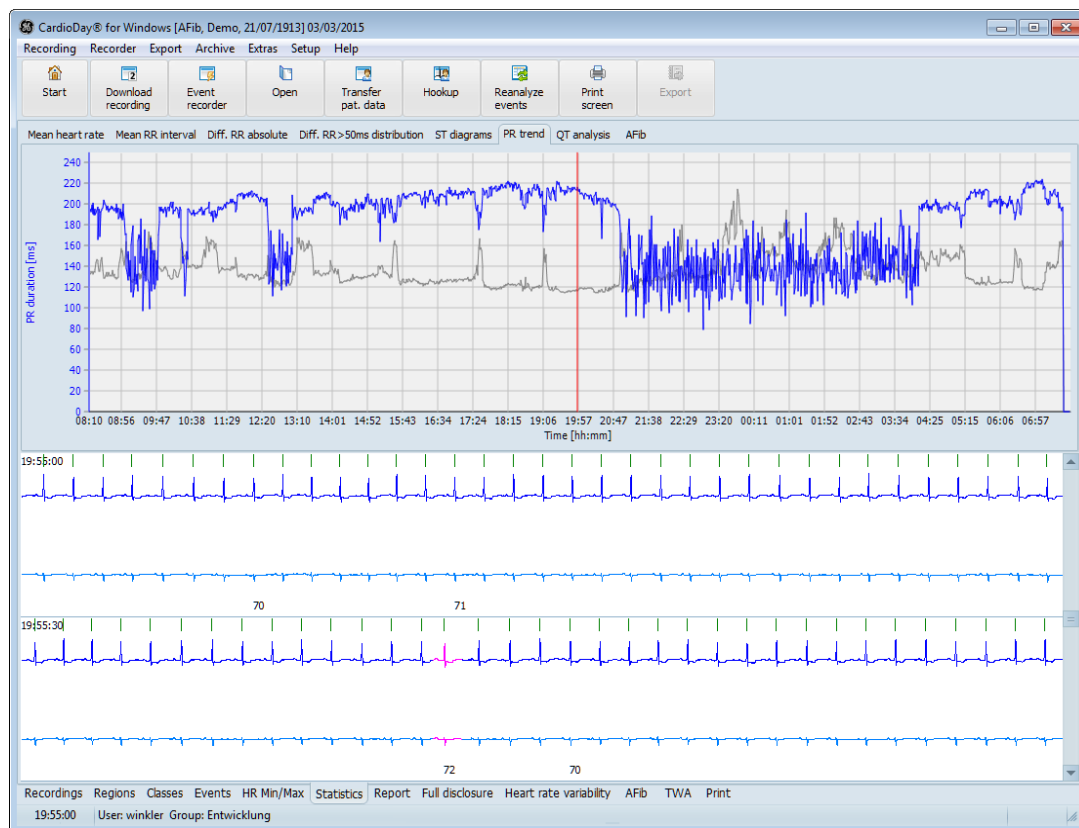
When you start dragging the mouse, a small circle will appear around your mouse pointer. As long as the mouse pointer is inside the circle, you mark a region; when the mouse pointer leaves the circle, the zoom function is activated.

PR trend

The **PR time** analysis can help to identify transmission problems, in particular in the case of a first-degree AV block.

The **PR trend** tab shows the **PR times** averaged over a period of one minute. These are calculated by determining the time of occurrence of the R peak (T_0) for 4 QRS complexes and then adding up the signals in the period $T_0 - 240$ milliseconds to $T_0 - 56$ milliseconds before the peak. This makes it easier to distinguish the P signal from noise. The time of this aggregate signal maximum is used as the P time to calculate the PR time using T_0 . The relevant values of one minute are averaged.

The Statistics tab



Statistics tab > PR trend

QT analysis

NOTE:

If triggering is correct and ECG signals are free of artifacts, the values of the QT_c times are lower than 450 milliseconds. The occurrence of higher values can indicate prolonged re-polarization, caused by medication, inherited or acquired reasons (long QT syndrome), with the risk of severe ventricular dysrhythmia occurring.

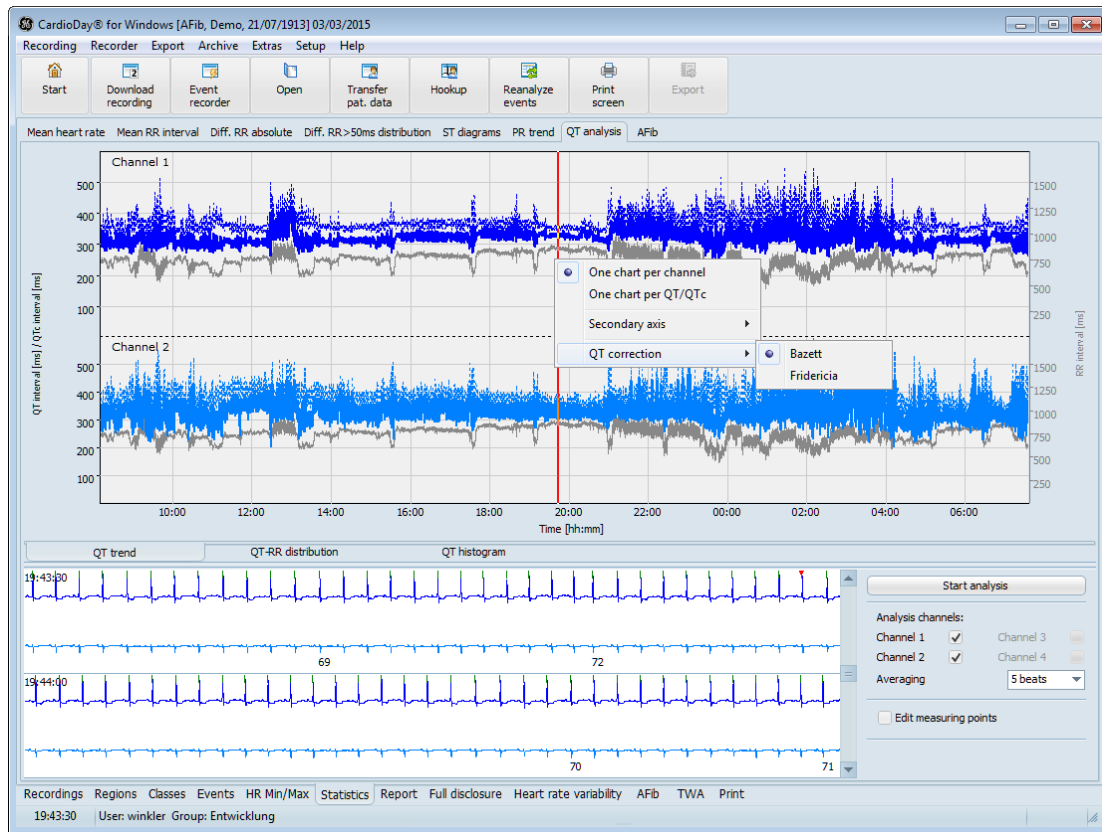
The **QT analysis** module serves to calculate the QT duration (Q_{Start} to T_{End}) and the corrected QT duration for the CardioDay channels.

The automatic measurement of the QT duration can be performed beat-to-beat or for averaged beats. You can set the number of beats used for averaging between 3 and 61.

The **QT trend**, the **QT-RR distribution**, and the **QT histogram** can be calculated and graphically displayed. On each sub-tab you can include or exclude the channels for analysis.

You can manually correct the measuring points Q_{Start} , J_{Point} , and T_{End} for every beat.

QT trend



Statistics tab > QT analysis > QT Trend

On the sub-tab **QT trend**, the QT durations (continuous curve) and corrected QT durations (dashed curve) are displayed for every beat or averaged beats.

For the **Secondary y-axis**, you can select the **RR interval** or the **Noise** in μV (root mean square of successive differences [rmssd] in a 20 ms window around T_{End}).

Start / Stop analysis

You can select the **Analysis channels** and the number of **Beats** for **Averaging**. Select **None** if you do not wish to have averaging. By doing so, a beat-to-beat analysis is performed. You can set the number of beats used for averaging between 3 and 61.

You can select whether one diagram per channel or per QT/QT_c is displayed.

Click the **Start analysis** button. If data of an earlier analysis exist, these are overwritten.

While CardioDay is performing the analysis, the curves, together with the even and odd beats, are updated on the screen at regular intervals.

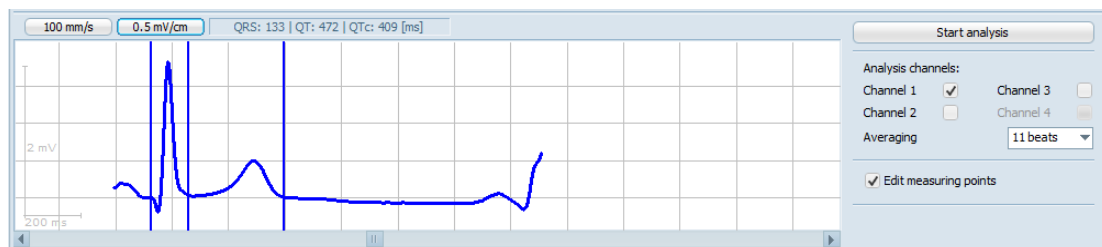
If you click the **Stop analysis** button, the data calculated up to this point will be displayed.

The analysis results are saved automatically. They are stored also if CardioDay is closed so that they will be available after reopening.

Edit measuring points

If you activate the option **Edit measuring points**, the points Q_{Start} , J_{Point} , and T_{End} are displayed in the ECG context. The active channel for which you can edit the measuring points is displayed as a thicker line, and the marker lines of the measuring points are drawn over the full height of the coordinate system.

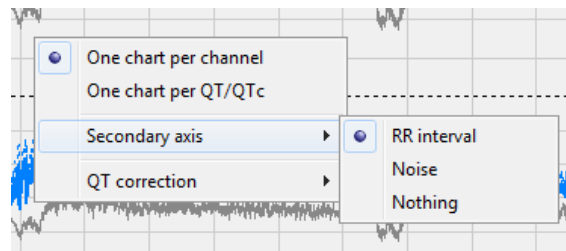
To select a channel, click on the ECG waveform of this channel. Now you can change the position of the measuring points by clicking and dragging the marker lines with the mouse.



Statistics tab > QT analysis > QT trend > Edit measuring points

Secondary y-axis

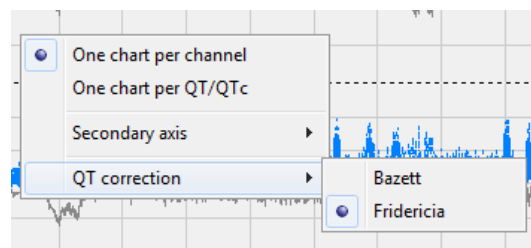
In addition to the QT and QT_c interval on the primary y-axis, you can select **RR interval**, **Noise**, or **Nothing** for the secondary y-axis on the right.



Statistics tab > QT analysis > QT trend > context menu secondary y-axis

QT correction

Corrected QT intervals are labeled with QT_c . As correction formulas, **Bazett** or **Fridericia** can be selected.



Statistics tab > QT analysis > QT trend > context menu QT correction

$QT_c = \frac{QT}{\sqrt{RR}}$	Bazett formula
$QT_c = \frac{QT}{\sqrt[3]{RR}}$	Fridericia formula

QT-RR distribution

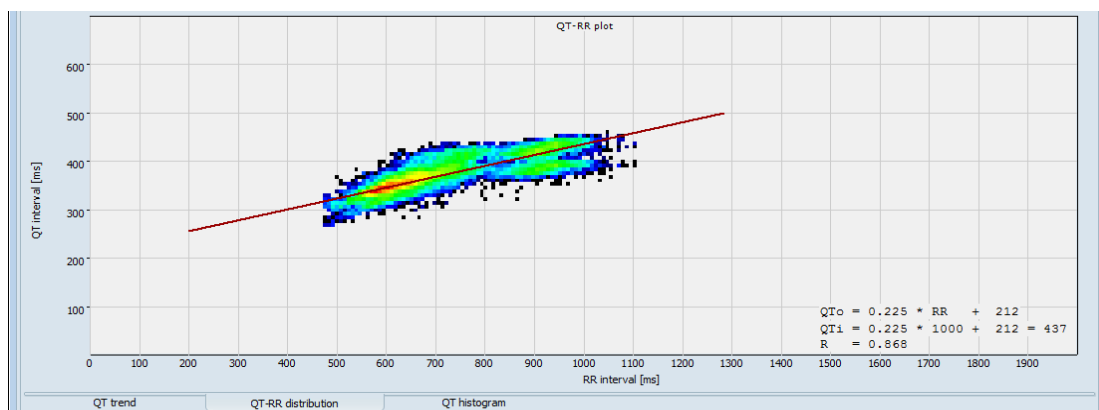
For the selected channels, the QT intervals are plotted against their preceding RR intervals. The density of the points being at the same place is color-coded from black, blue, through green to yellow and finally red.



Statistics tab > QT analysis > QT-RR distribution > context menu display area

The straight of the linear regression of the distribution, the QT_o , the individualized QT correction (QT_i), as well as the regression coefficient are displayed.

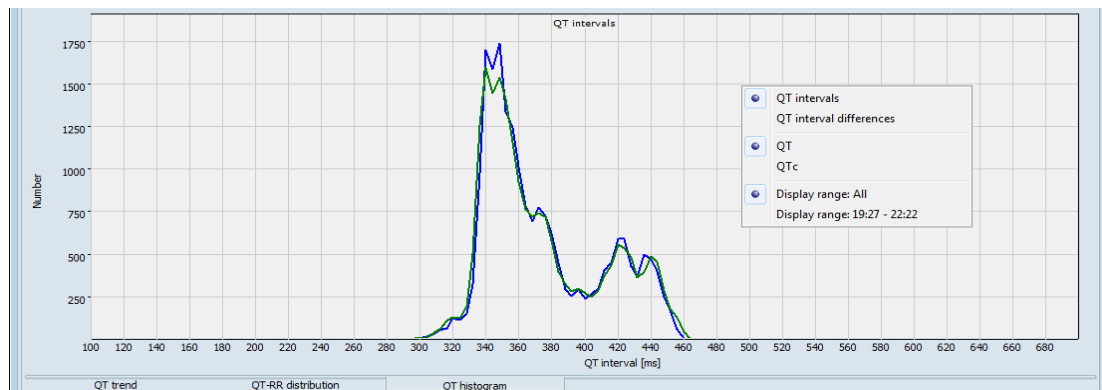
If you have zoomed the display on the sub-tab **QT trend**, you can limit the display of the **QT-RR distribution** to the time segment of this zoom. Right-click in the **QT-RR distribution** and select “**Display range: xx:xx – xx:xx**” in the context menu. The **QT-RR distribution** is displayed only for this segment.



Statistics tab > QT analysis > QT-RR distribution

QT histogram

You can select via the context menu whether the histogram displays the distribution of the intervals or that of the interval differences for QT or QT_c.



Statistics > QT analysis > QT histogram

If you have zoomed the display on the **QT trend** sub-tab, you can limit the display of the **QT histogram** to the time segment of this zoom. Right-click in the QT histogram and select “**Display range:** xx:xx – xx:xx” in the context menu. The **QT histogram** is displayed only for this segment.

AFib – Detection of atrial fibrillation

On the **Statistics** tab, the **AFib** sub-tab displays recording episodes in which possible phases of atrial fibrillation have been detected.

Statistical calculation

CardioDay calculates a fibrillation index on the basis of the RR intervals previously detected. The higher the fibrillation index is, the greater the irregularity of the RR intervals.

The fibrillation index is calculated mainly from the histogram of the RR interval differences.

Background information / Relevance

Regions in which the fibrillation index achieves higher values indicate the presence of atrial fibrillation. Such regions are highlighted and editable.

NOTE:

Also, in the case of patients with certain ventricular dysrhythmia, the fibrillation index may reach high values, although no actual atrial fibrillation is present. Thus, if in doubt, perform a visual inspection of the detected regions in the ECG to validate the occurrence of atrial fibrillation.

Explanation of the displays and color assignments

The upper display shows the calculated fibrillation index as a green curve and the periods with possible indications of atrial fibrillation as colored regions.

These regions are editable, and new ones can be created manually.

- To change the position, beginning, or ending of a region, perform the following steps:
 - Move the mouse over the middle, beginning, or ending of a region.
 - Click and hold the left mouse button and move the mouse until the position, beginning, or ending have the desired position.
- To delete a region, mark the region by left-clicking within it and press the **Delete** key.
- To create a new region, left-click at the desired beginning, hold the mouse button and move the mouse to the desired ending of the region.

The list on the right side itemizes the detected regions of possible atrial fibrillation numerically and shows detailed information such as beginning and end times, duration, and mean fibrillation index. The last line of the list shows the total amount of all regions. You may customize your report to include this information.

- To mark a region in the fibrillation index, click and highlight the corresponding item in the list.

The red line indicates the starting point of the ECG displayed in the lower half of the screen. You can change this point of time by left-clicking in the upper display.

The Statistics tab



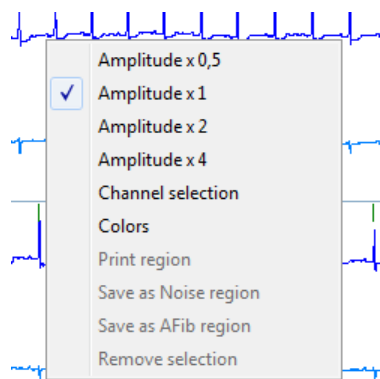
The Statistics tab > AFib tab

- To magnify a section of the upper display, drag a rectangle from top left to bottom right with the mouse.
- To undo the magnified view, briefly drag the mouse from bottom right to top left.

Context menu options

If you have marked a region with the mouse, you can print and/or save this region either as a Noise region or as a region of atrial fibrillation.

Click on the line marking to open the context menu.



Statistics > AFib > Regions context menu

11

The Report tab

The **Report** tab helps you to write the examination report. The program will automatically pull up a standard report, to which you can make individual adjustments and additions. The report is comprised of a software-generated **Summary** and your **Diagnosis**.

You can select customized report summary templates from a dropdown list.

If you click the **Text modules** button or press **Ctrl+Space**, you can access the existing text modules.

NOTE:

To create or change a report using an existing report template, you need the user or user group right **Create report** and/or **Change report** assigned to your user credentials.

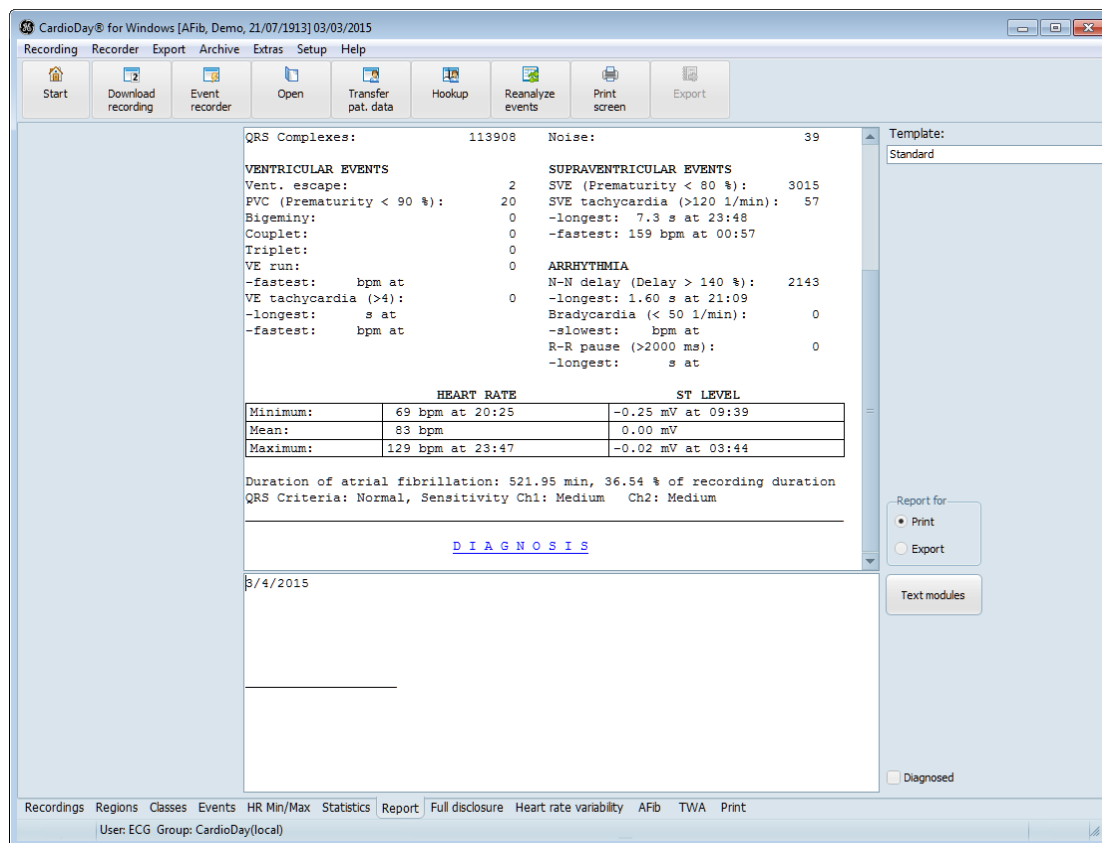
To create, edit, and delete customized report templates, you need the user or user group right **Setup (advanced)** assigned to your user credentials.

For details on user rights, refer to "[Setup > User administration...](#)" on page 246.

The software-generated Summary of the report

NOTE:

We recommend the software-generated summary of the report not be changed.



Report tab

The upper part of the window displays the software-generated **Summary** of the analysis results. The **Summary** will be updated whenever you switch to the **Report** tab.

When a report is generated, CardioDay automatically selects the report template depending on the recording type.

The following templates are installed:

Report template	Function
Standard	Standard report layout
Pacemaker	Standard report layout for pacemaker recordings
Export	Standard report layout when exporting the report to a hospital information system
Export PM	Standard report layout for pacemaker recordings when exporting the report to a hospital information system
Export event re-corder	Export of event episodes imported from an event re-corder
Event Recorder	Standard report layout for event recordings
Long recordings	Standard report layout for recordings of more than 48 hours

Report template	Function
Long recordings PM	Standard report layout for pacemaker recordings of more than 48 hours
Export long recordings	Standard report layout when exporting the report of recordings of more than 48 hours to a hospital information system
Export long recordings PM	Standard report layout when exporting the report of pacemaker recordings of more than 48 hours to a hospital information system

You can select customized report templates by clicking the **Template** field in the upper right corner of the window.

Using the “[Variables for customizing the report templates](#)” on page 259, you can edit the content of the software-generated summary of the report and save your changes for further use. For the necessary explanations, refer to “[Customizing and saving report templates](#)” on page 236.

The Diagnosis part of the report

NOTE:

To generate the diagnosis, you need the user or user group right **Generate diagnosis** assigned to your user credentials.

To edit an existing diagnosis that has already been marked as **Diagnosed**, you additionally need the user or user group right **Change report**.

For details on user rights, refer to “[Setup > User administration...](#)” on page 246.

Below the **Summary**, you enter your **Diagnosis. Text modules** and an automatic, “intelligent” **Word and Phrase auto-completion** are provided to reduce the time consumption of writing your diagnosis.

The text module editor is integrated to allow you to easily retrieve your saved standard text passages when writing reports. To view the text passages available, press **Ctrl+Space**. Select the text passage required and press **Enter** (or double-click with the mouse). Alternatively, you may use the hotkey combination previously defined while generating the text passage to enter the text into your report.

You find additional information on using the text processing tools in “[Setup > Report > Advanced > Text modules](#)” on page 239 and in “[Setup > Report > Advanced > Word- and phrase auto-completion](#)” on page 241.

After you have written your diagnosis, you can lock it for other users by putting the checkmark for **Diagnosed**. The report will now appear grayed out. After unchecking, the report can be edited again.

NOTE:

Depending on the setting in **Setup > Other options > MUSE connection > Exclude diagnosis on printed report**, the text entered in the diagnosis section is not displayed in the report that is printed or exported to PDF.

Printing a logo

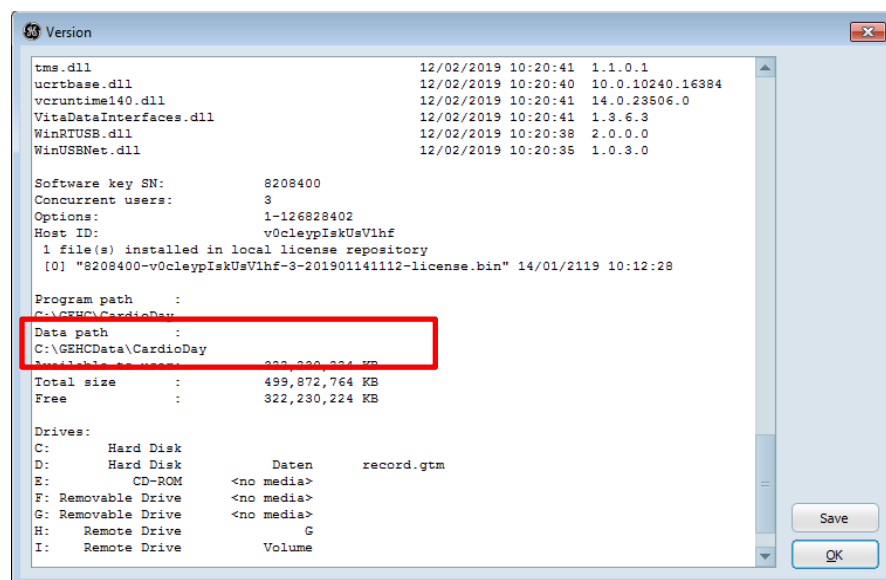
To print your corporate logo in the head of the report, save the logo as a bitmap file called **"Logo.bmp"** in the CardioDay data directory. The bitmaps will be scaled to size in the report.

Name: Doe, John	Date of Birth: 24/08/1932	Date: 01/03/2014
ID number: 1234501	Gender: M	Channel: 1+2 Page: 1/15



Clinic Cardiology	Holter ECG
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To locate the directory, select **Help > Version** and find the **Data path** variable near the bottom of the window.

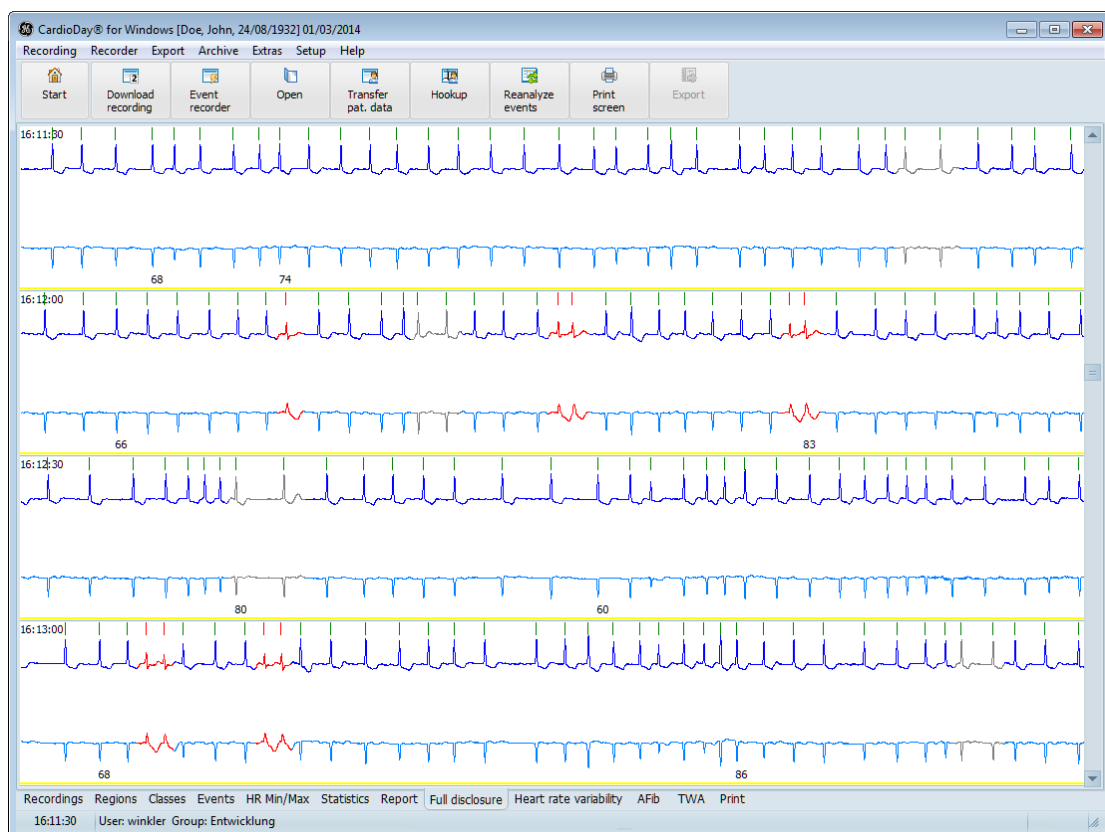


CardioDay data directory in the Help > Version sub-menu

12

The Full disclosure tab

The **Full disclosure** tab shows the entire ECG line by line.

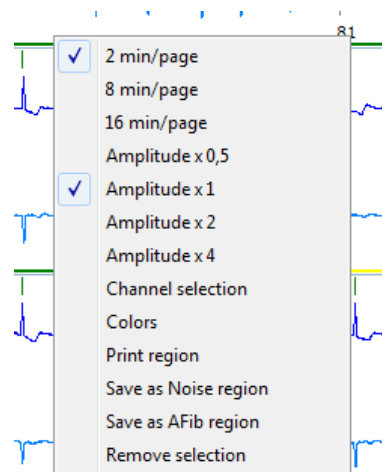


Full disclosure tab

- ECG segments marked on the **Regions** tab as noise regions are shown here on the **Full disclosure** tab via a red line.
- ECG segments detected as atrial fibrillation are shown here via a yellow line.
- A red arrow head pointing downwards shows the current time on the **Classes** or **Events** tab.

You can mark segments by clicking and dragging with the mouse.

By right-clicking on the green line, you open a context menu where you can designate these segments for printing or mark them as either noise regions or as regions of atrial fibrillation.



Full disclosure tab, context menu regions

You can browse through the entire data using either the arrow keys or the scroll bar on the right of the screen.

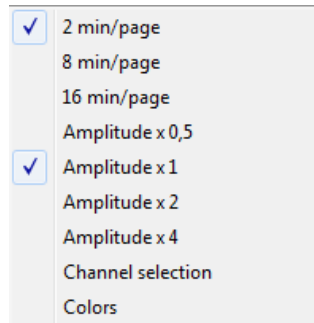
- The time of the beginning of each ECG strip is displayed on the left of the screen.
- The two numbers displayed along the bottom of each ECG strip correspond to the minimum and maximum heart rates of the respective line.
- Detected beats are marked by a line above the R peak.

The lines are color-coded as follows: normal beats are green, pathological beats are red, and beats stimulated by a pace-maker (not shown in the previous example) are blue.

The color-coded beat representation allows you to quickly see if a beat belongs to the group of ventricular (red) or supraventricular (yellow) events. Other events are displayed in black.

Beats not ordered to a particular event group are displayed in the color ordered to the ECG waveform.

Use the right mouse button to open the context menu for the screen magnification, channel, and color selection.

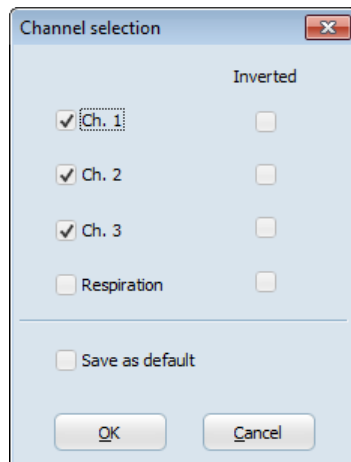


Full disclosure tab, screen magnification and channel selection

NOTE:

The “[Setup > Screen, Scale, and Colors](#)” window, as explained on page 225, opens here if you wish to modify the displayed colors.

For the channel selection, an additional window opens.



Full disclosure tab, channel selection window

Select the ECG channels to be displayed using the channel selection window. You cannot select more than two channels for simultaneous analysis.

Furthermore, you may invert the polarity of the ECG waveforms using the **Inverted** function.

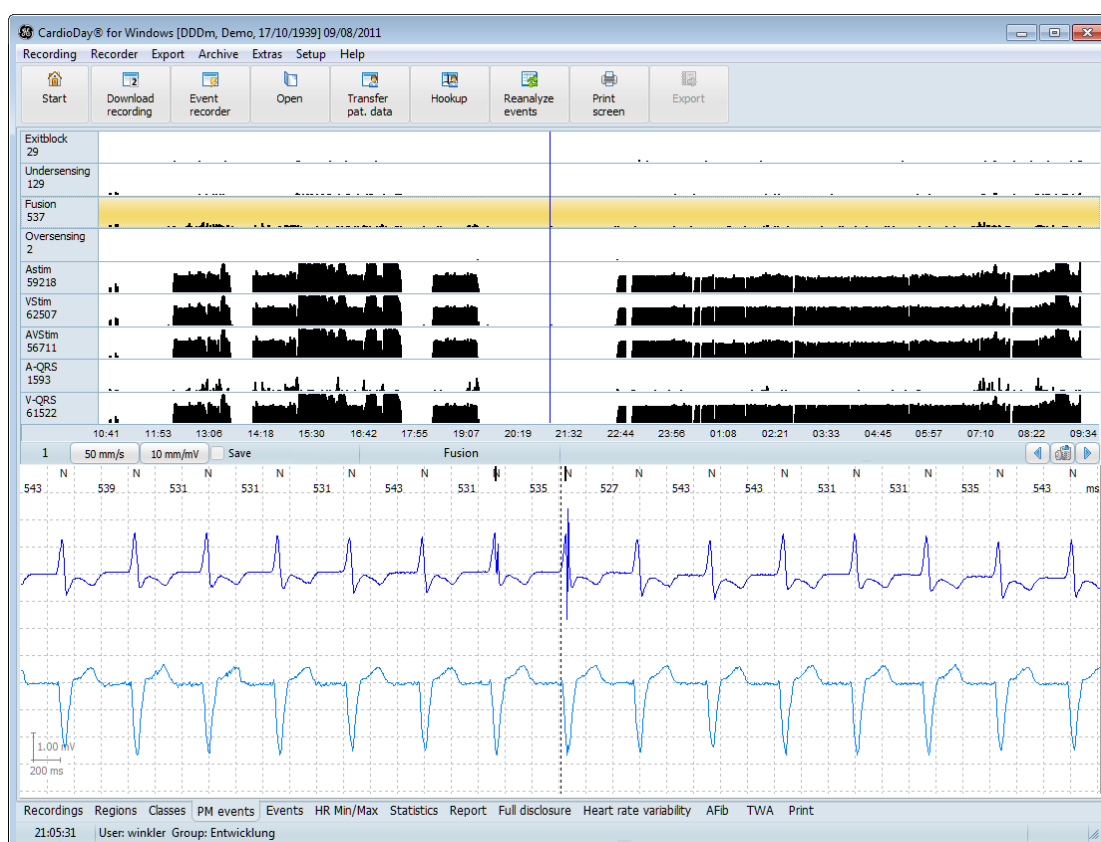
13

The PM (Pacemaker) events tab

NOTE:

For the pacemaker analysis, it is necessary that the pacemaker parameters have been entered when downloading or reanalyzing. Please refer to the section “[Pacemaker parameters and pulse widths](#)” on page 38 for further information.

The screen layout is the same as on the **Events** tab, except that the top half of the workspace shows event classes related to the pacemaker.



PM (Pacemaker) events tab

Detectable pacemaker event classes

The following pacemaker event classes are displayed:

Pacemaker event	Description
<i>Exitblock</i>	Ineffective stimulation (exit block)
<i>Undersensing</i>	Premature stimulation (undersensing)
<i>Fusion</i>	Stimulation in the QRS complex
<i>Oversensing</i>	Delayed stimulation (oversensing)
<i>Astim</i>	Atrial stimulation
<i>Vstim</i>	Ventricular stimulation
<i>AVstim</i>	AV-sequential stimulation
<i>A-QRS</i>	Atrial stimulation with independent transmission
<i>V-QRS</i>	Ventricular stimulation with subsequent QRS complex

Basis for the analysis and evaluation of pacemaker events

The basis for pacemaker analysis is reliable detection of the pacemaker's stimulation impulses and of the R peak in the QRS complex.

Because the P waves in the surface ECG cannot be reliably detected from beat to beat, the behavior of AAI and dual-chamber pacemakers can only be detected by examining the behavior of the R peak over time in relation to the stimulation impulse from the chamber and atrium.

The automatic pacemaker analysis can be improved significantly with measuring the width of the stimulation impulse during the recording of the pacemaker ECG and using this information to locate the stimulation.

Analysis algorithms of the stimulation impulse differentiation

The detection of ventricular stimulation pulses is marked by long trigger marker lines in the respective ECG context display. The detection of atrial stimulation pulses is marked by short trigger marker lines.

When analyzing pacemaker recordings, please take into consideration the following analysis algorithms:

Effective stimulation in the ventricle (V-QRS)

If a ventricular stimulation impulse is detected, the program investigates whether a QRS complex is detected within the period of 8 to 200 milliseconds after the stimulation.

Effective stimulation in the atrium (without oesophagus lead)

If an atrial stimulation impulse is detected, the program investigates whether a QRS complex is detected in the period of 100 to 300 milliseconds after the stimulation.

AV-sequential stimulation (A-Pace, V-Pace) without differentiation of the width of the stimulation impulse

If two successive stimulation impulses are detected at a period of less than 300 milliseconds, the first impulse is taken to be the atrial pacemaker stimulation impulse.

Exit block

- An exit block is assumed to have occurred if no R wave is detected between 8 and 200 milliseconds after a ventricular stimulation.
- An exit block is assumed to have occurred if no R wave is detected between 8 and 300 milliseconds after an atrial stimulation.

Oversensing

If the stimulation period (T_a) between two ventricular stimulations is longer than T_a times 1.15, and there is no sensing event between the stimulations, then oversensing is assumed.

If the escape time or hysteresis time is increased by more than 15% after a detected QRS complex, then oversensing is assumed.

Undersensing

If, in relation to the last detected ventricular stimulation or the last detected QRS complex, a QRS complex is detected which occurred earlier than the minimum stimulation period times 0.85, then undersensing is assumed.

Fusion beats

If the start of a QRS complex is detected before the stimulation and the stimulation occurs within 40 milliseconds after the R peak, this stimulation is called a fusion.

Independent transmission in DDD pacemakers (A-QRS)

If an atrial stimulation and a QRS complex are detected within a period of 100 to 300 milliseconds, this event is interpreted as an independent transmission.

Synchronous behavior of DDD pacemakers

If the DDD pacemaker only has ventricular stimulation, then an independent atrial stimulation was detected by the pacemaker.

14

The Heart rate variability tab

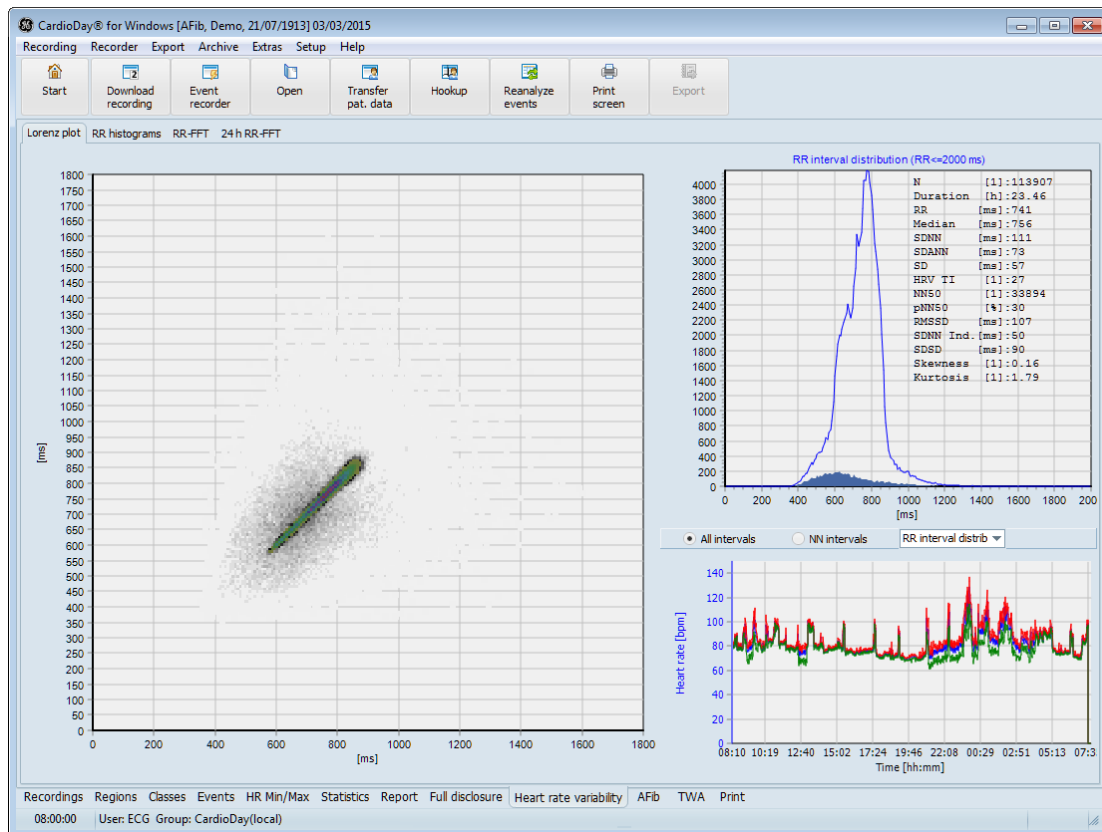
This tab displays the **Heart rate variability** in the time and frequency domain.

Heart rate variability > Lorenz plot and Interval distribution

The display of the Lorenz plot in the left half of the screen and the display of the heart rate in the bottom right screen quadrant can be magnified in the usual way. The zoom function of the heart rate in the bottom right screen quadrant in particular allows for the selection of any time interval from the entire recording period (with the other two diagrams being updated automatically) to enable detailed analyses of the Heart rate variability in the time domain.

Statistical calculation of the Lorenz plot

The RR Lorenz plot is generated by determining a coordinate of the graphic space from each RR interval and its predecessor.



Heart rate variability > RR Lorenz plot

The left half of the screen shows the RR Lorenz plot. Each RR interval on the ordinate is plotted against its previous RR interval on the abscissa. Furthermore, the frequency distribution of the RR interval pairs displayed is color-coded (so-called color-coded box counting), allowing the detection of rhythm problems at a glance.

Relevance of the RR Lorenz plot

With low Heart rate variability, the RR interval pairs arrange themselves along the bisecting line. The extension along the bisecting line is mostly caused by the day-to-night difference in the middle RR interval. The angle against the bisecting line is created by the average beat-to-beat variability and, for example, is significantly increased with atrial fibrillation as compared to sinus rhythm.

Statistical calculation of the interval distribution

The upper right screen quadrant displays the absolute frequency distribution of all RR intervals smaller than or equal to 2000 milliseconds in blue. The frequency distribution of all RR intervals not located between normal beats is drawn in red.

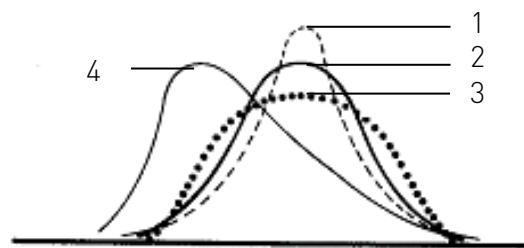
Below this display, you can select between the display of **All Intervals** and **NN Intervals**. The **NN Intervals** selection only considers the RR intervals located between normal beats. According to the selection made, the RR Lorenz plot in the left half of the screen and the absolute frequency distribution in the top right screen quadrant are updated instantly, so you can see the effect of the selection on the Heart rate variability in the time domain by switching between the two.

Relevance of the interval distribution

In addition to the absolute frequency distribution, a number of values are displayed. The parameters and calculation procedures are designated according to table 1 of the following guideline: European Heart Journal (1996) 17, 354–381, Guidelines, Heart rate variability, Standards of measurement, physiological interpretation, and clinical use. Task Force of The European Society of Cardiology and The North American Society of Pacing and Electrophysiology.

Value	Description
N	Number of all considered RR intervals
Duration	Total duration of all considered RR intervals in hours
RR	Linear average value of all considered RR intervals in milliseconds
Median	Median of all considered RR intervals in milliseconds
SDNN	Standard deviation of all considered RR intervals in milliseconds
SDANN	Standard deviation of the average RR interval calculated every five minutes in milliseconds
SD	Standard deviation in milliseconds of the standard deviation of all considered RR intervals calculated every five minutes
HRV-TI	Dimensionless triangular index of the Heart rate variability
NN50	Number of RR intervals of which the difference from the previous RR interval was larger than 50 milliseconds
PNN50	Percentage of RR intervals of which the difference from the previous RR interval was larger than 50 milliseconds
RMSSD	Square root of the mean squared differences between consecutive RR intervals in milliseconds

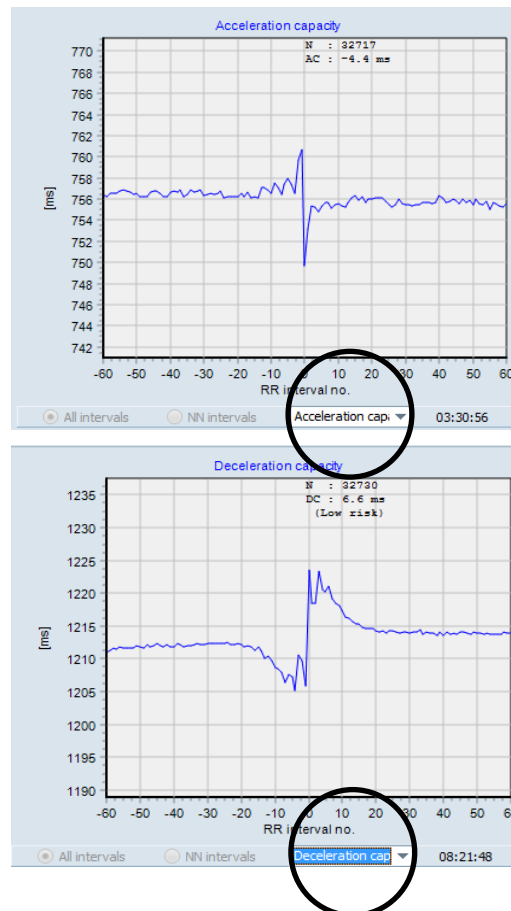
Value	Description
<i>SDNN Ind. or SDNN Index</i>	Mean standard deviation of the standard deviations of all considered RR intervals calculated every 5 minutes
<i>SDSD</i>	Standard deviation of the differences of all consecutive considered RR intervals in milliseconds
<i>Skew and Kurtosis</i>	Power moments of the third or fourth order, clarifying the deviation of the considered RR intervals distribution from the normal distribution according to the following schematic illustration:



1. leptokurtosis, positive excess
2. normal
3. platykurtosis, negative excess
4. positive skew, left-skewed curve

Deceleration and Acceleration capacity

By clicking the field highlighted, you can toggle between the **RR interval distribution**, the **Deceleration capacity**, and the **Acceleration capacity**.

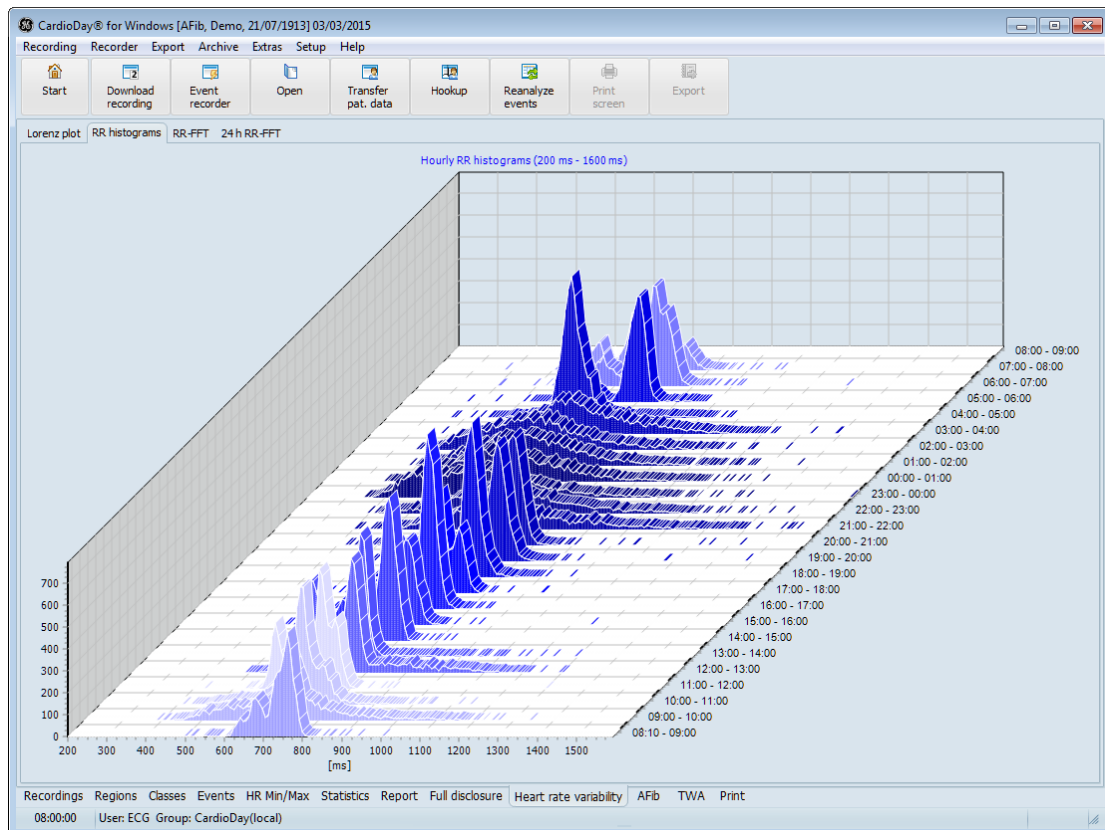


Deceleration and Acceleration capacity

Heart rate variability > RR histograms

This kind of graphical display allows for a quick overview of the RR interval distribution over the hours of the day. Wider distributions with relatively high standard deviations typically occur during hours with intermittent atrial fibrillation or during hours in which the RR intervals change significantly (stages of falling asleep and waking up).

The Heart rate variability tab



RR-variability > RR histograms

The **RR histograms** sub-tab displays the distributions divided in hours of the day of all RR intervals between 200 milliseconds and 1600 milliseconds in blue. The graphics of the hourly histograms are auto-scaled, which means that the maximum class frequency is set as the maximum vertical coordinate.

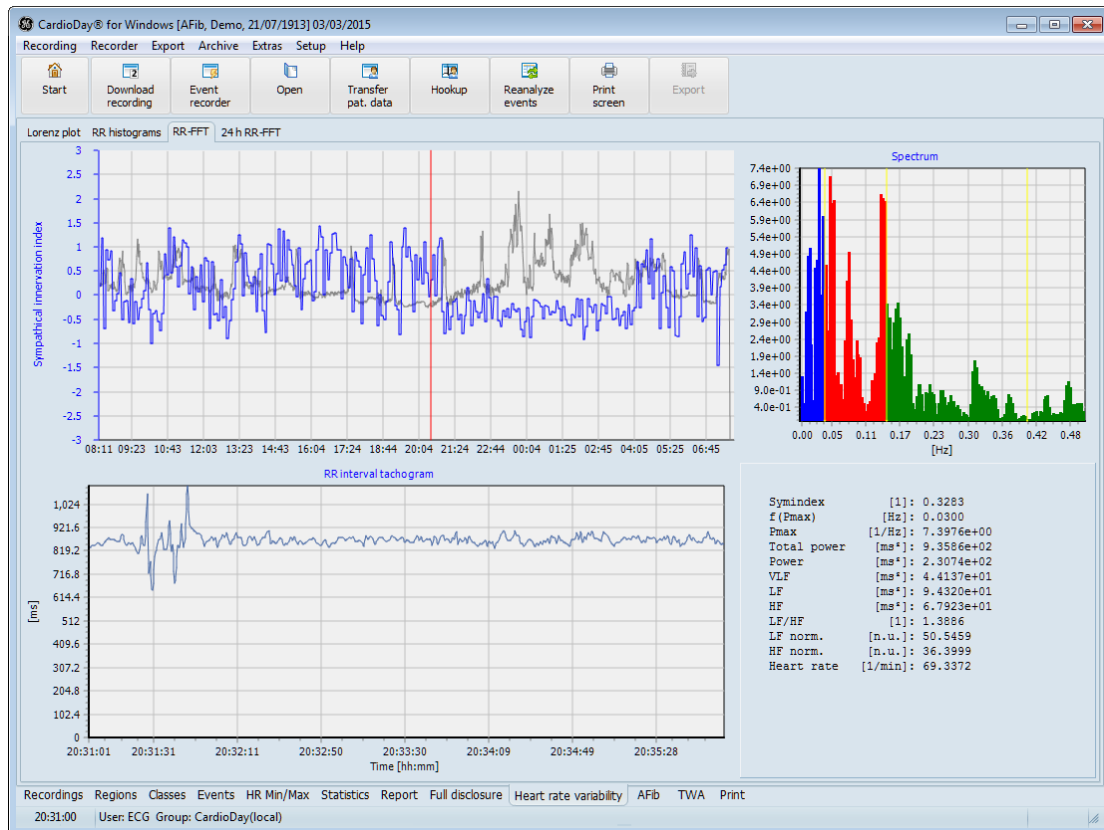
The darkest shade of blue corresponds to midnight, the lightest blue to midday.

In the printout, the value of the maximum class frequency for each hour is displayed at the left border of the graph. The class width, which is used to calculate the frequency distribution, is 8 milliseconds.

On the right border of the graph, the period of the individual distribution is displayed; in the printout the number of RR intervals between 200 milliseconds and 1600 milliseconds falling into this period, as well as the average RR interval and its standard deviation ($\bar{x} \pm s$), are also displayed. Furthermore, the class containing the average RR interval is displayed in red within the blue frequency distributions of the printout.

Heart rate variability > RR-FFT

In the top left screen quadrant, the **RR-FFT** sub-tab on the **Heart rate variability** tab shows the sympathetic innervation index over the recording period. This coefficient clarifies the effect of respiration on Heart rate variability, which is very strong in healthy people, e.g., during sleep.



Heart rate variability > RR-FFT

Statistical calculation

The sympathetic innervation index is calculated from consecutive time windows of 5-minute duration.

First, the RR interval function is calculated from the time series of RR intervals. This is achieved by setting each RR interval value against the elapsed time before it occurs. Only the RR intervals between consecutive normal beats are used. Extra beats and compensatory pauses are interpolated also, if they occur in a repetitive manner. Interposed extra beats are deleted. During this procedure, it does not matter whether the extra beats are from supraventricular or ventricular origin. This results in an RR interval sequence that represents only the variation of the sinus node rate. Disturbances from extra beats are eliminated.

Second, the RR interval function is sampled at 1024 equidistant points within each 5-minute time window. The sampled RR interval values are calculated from the RR interval function using linear interpolation.

This procedure was recommended in the following guideline: European Heart Journal (1996) 17, 354–381, Guidelines, Heart rate variability, Standards of measurement, physiological interpretation, and clinical use. Task Force of The European Society of Cardiology and The North American Society of Pacing and Electrophysiology.

The 1024 RR interval values that result in each time window of 5-minute duration are normalized: Every RR interval value is replaced by its deviation from the mean RR interval within the actual window and then it is divided by the mean RR interval. Because of this division, the time dimension of the RR interval values disappears and the values are without units. After weighting the data using the Hanning function, a Fast Fourier Transformation (FFT) is carried out and the periodogram is calculated. In order to diminish the variance of the spectral estimators, the periodogram is smoothed using a three points moving average filter.

The resulting spectrum is divided into four spectral bands (ULF, VLF, LF, and HF) using changeable limit frequencies (menu “Setup > RR-FFT”).

Spectral bands	Frequency limits
ULF	below 0.003 Hz
VLF	0.003 Hz to 0.04 Hz
LF	0.04 Hz to 0.15 Hz
HF	0.15 Hz to 0.40 Hz

Because the observing period is only 5 minutes, main attention should be given to the LF and HF frequency band. In the upper frequency band HF, the modulation of heart rate by the respiration rate (i.e., the respiratory sinus arrhythmia) appears mainly during nighttime if there are few other modulations.

Finally, the spectral power in the LF and HF frequency bands is calculated and the logarithm of their ratio ((LF)/(HF)) is the sympathetic innervation index (Symindex).

$$\text{Sympathetic Innervation Index} = \log \left(\frac{\sum P_{LF}}{\sum P_{HF}} \right)$$

Background information / Relevance

The sympathetic innervation coefficient is positive if the spectral power prevails in the LF frequency band, which indicates a predominantly sympathetic cardiac innervation.

The sympathetic innervation coefficient is negative if the spectral power prevails in the HF frequency band, which indicates a predominantly parasympathetic or vagal cardiac innervation.

Because each sympathetic innervation index is calculated from a time window of 5 minutes, the bottom left screen quadrant displays the RR interval function present during the selected 5-minute period.

You can zoom both the display of the sympathetic innervation index in the top left quadrant and the display of the corresponding RR interval function with a duration of 5 minutes in the usual way.

When selecting a point in time of the RR interval function by double-clicking with the left mouse button, the display jumps to the ECG context belonging to this RR interval (which may have been obtained by interpolation). This way the interpolation process of RR intervals caused by extrasystoles can be reconstructed. When changing to the **Full disclosure** main tab, the ECG section displayed is positioned at the start of the selected 5-minute period.

The top right screen quadrant displays the RR interval spectrum, which was calculated according to the procedure described on the **RR-FFT** sub-tab of the **Statistics** main tab from the scanned, normalized, and weighted RR interval function.

The boundaries between the individual frequency bands are marked with yellow vertical lines.

A number of values are displayed in the bottom right screen quadrant:

Value	Description
Symindex	dimensionless value of the sympathetic innervation index during the selected 5-minute period
f(Pmax)	frequency in Hertz where the maximum spectral power occurred
Pmax	value of this maximum spectral power Because the RR interval values considered for the FFT became dimensionless due to the normalization process, the unit of the spectral power here is [1/Hz].
Total power	variance of the interpolated RR interval function in milliseconds squared, calculated in the time domain before the normalization process
Power	the power present in the entire RR interval spectrum, dimensionless due to the normalization process of the RR interval
VLF	spectral power in the VLF frequency band
HF	spectral power in the HF frequency band
LF/HF	LF-to-HF ratio
LF norm. and HF norm.	power in the frequency band referred to the total power minus the power in the other frequency band in normalized units (n. u. means normalized) The following applies: $HF_{norm.} = HF / (total\ power - VLF) * 100,$ and $LF_{norm.} = LF / (total\ power - VLF) * 100$

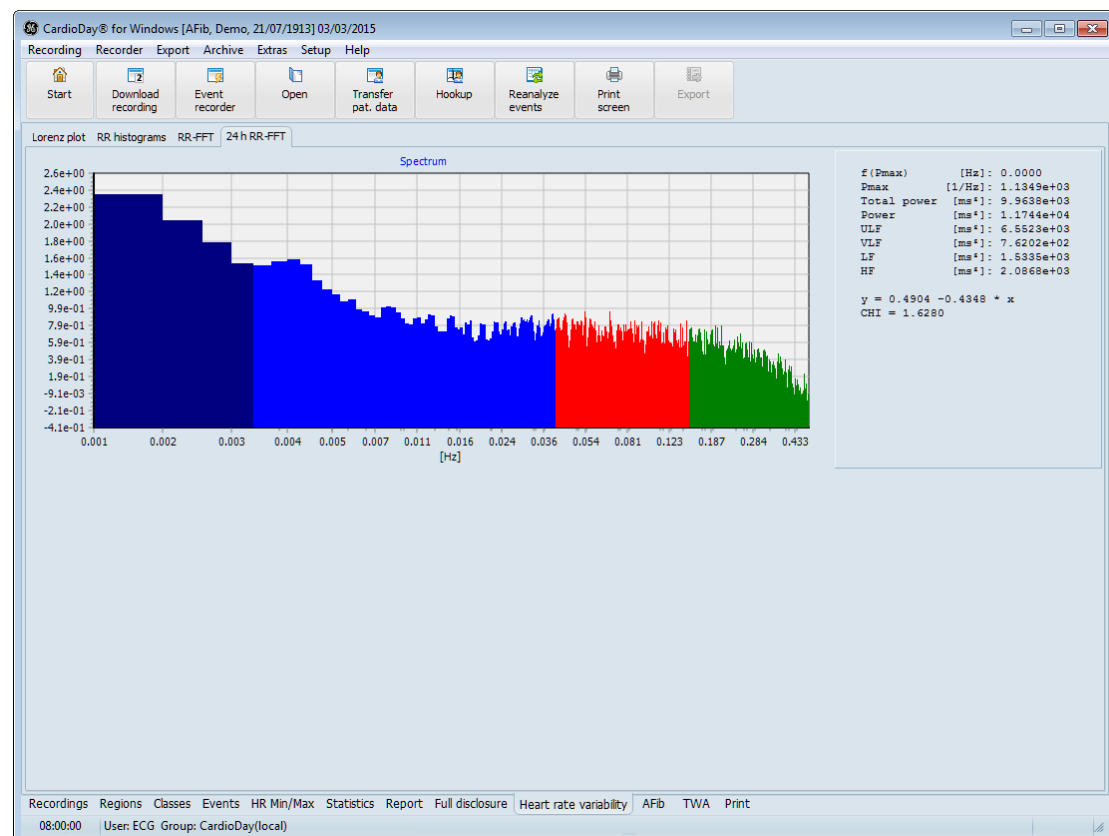
The Heart rate variability tab

Value	Description
Heart rate	Average heart rate calculated from the average RR interval of the minute section in beats per minute
Respiratory rate	If there is an occurrence of a discrete, high spectral power peak in the HF band, this is used to calculate and display the respiratory rate.

Furthermore, the **Report** contains further comments on the RR interval spectrum, depending on selection and contents of the report templates in the RTF files.

Heart rate variability > 24h RR-FFT

The upper half of the screen of the **24h RR-FFT** sub-tab of the **Heart rate variability** main tab displays the results of the RR spectral analysis over the entire recording period. If the recording period is 48 hours, the results of the second recording day are displayed in the lower half of the screen:



Heart rate variability > 24h RR-FFT

Unlike the spectro-temporal analysis of subsequent time segments of 5 minutes, the analysis over the entire day also allows the detection of low-frequency components of the spectrum (VLF and ULF frequency band).

The frequency boundaries of the four frequency bands (ULF, VLF, LF, and HF) can be set under "**Setup > RR-FFT options**" (see page 229). The spectra are calculated in the same manner as the 5-minute

spectra. The recording time, however, is now 24 hours instead of 5 minutes, and a Fourier transformation of the interpolated RR interval function is carried out with 262,144 scan values instead of 1,024.

The following values are displayed on the right-hand side of the spectra:

Value	Description
<i>f(Pmax)</i>	Frequency in Hz where the maximum spectral power occurred.
<i>Pmax</i>	Value of this maximum spectral power. Because the normalized RR interval values considered for the FFT became dimensionless due to the normalization process, the unit of the spectral power here is [1/Hz].
<i>Total power</i>	Variance still calculated in the time domain, before the normalization process, of the interpolated RR interval function in milliseconds squared
<i>Power</i>	The power present in the entire RR interval spectrum, dimensionless due to the normalization process of the RR interval
<i>ULF, VLF, LF, HF</i>	Spectral powers in the corresponding frequency bands

The regression line in the VLF frequency band is calculated by means of data fitting, minimizing the chi squared value. The equation of the regression line is displayed. Its slope value is close to the alpha value suggested in table 2 of the guidelines, if the boundaries of the frequency bands are selected accordingly.

15

The 12-channel ECG tab

NOTE:

Ambulatory ECG data from Holter recorders is not intended to be used as a substitute for a standard diagnostic quality resting 12-channel ECG.

The **12-channel ECG** tab helps you to evaluate long-term ECG recordings from the SEER 12, CardioMem CM 3000-12, and CM 3000-12 BT recorders, and to select an ECG section for measurement.

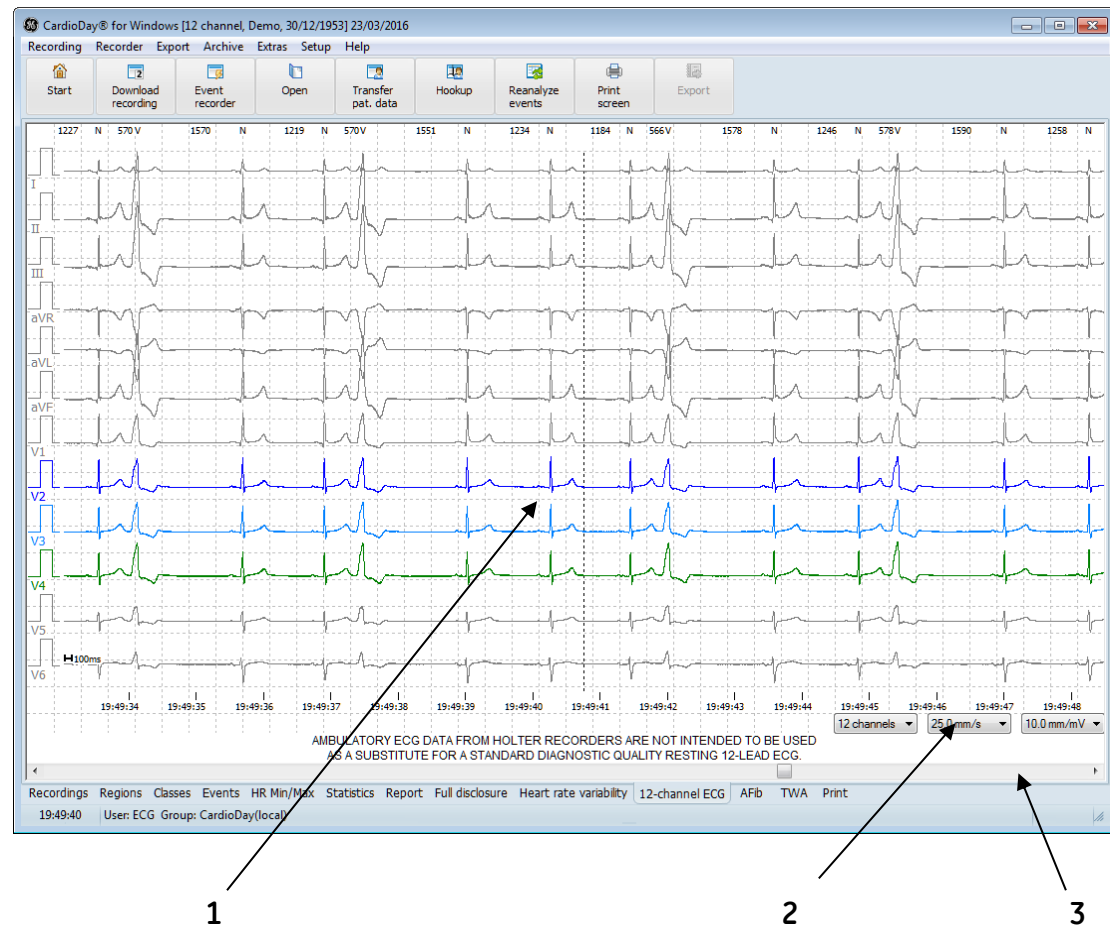
This tab is only available after opening 12-channel ECG recordings.

When switching to the **12-channel ECG** tab, the current ECG context of the last QRS complex or event displayed is shown.

Using the 12-channel module, the ECG data channels I, III, and V1-V6 are acquired. Channel II, avR, avL, and avF will be calculated using standard formulas of the Einthoven triangle.

Screen structure and operation

The screen of the **12-channel ECG** tab is divided (from the top to bottom) into the title bar, the menu bar, a context sensitive workspace, the toolbar, the tab bar, and the status bar.



CardioDay screen structure on the 12-channel ECG tab

1. In the workspace area, all 12 ECG channels or a selection are shown. Those ECG channels shown on the **Classes**, **Events**, and **Statistics** tabs are displayed with a different color.
2. Channel selection, speed, and channel amplitude can be adjusted using the controls at the bottom of the screen.
3. Using the slide control you can change the ECG section displayed.

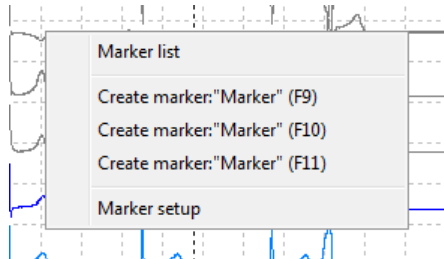
Measuring, editing, and exporting ECG sections

You can measure or edit any ECG section of the recording or export it in an XML format. You have to mark the corresponding ECG section before you can access the desired function.

Creating 12-channel markers

You can mark an ECG section for measuring or for export by setting a marker. You may also establish the length of the section associated with the marker. Default is ten seconds.

By clicking the right mouse button you will open a context menu showing **Create Marker: "Marker" (F9)**.

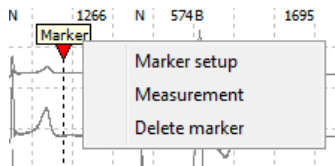


12-channel tab > Create marker

Use the function keys or click in the context menu to create markers.

General setup and print setup of 12-channel markers

If the 12-channel markers have not yet been set in the **Setup** menu and you want to customize them, you can open a context menu by right-clicking directly on the marker with a red triangle.



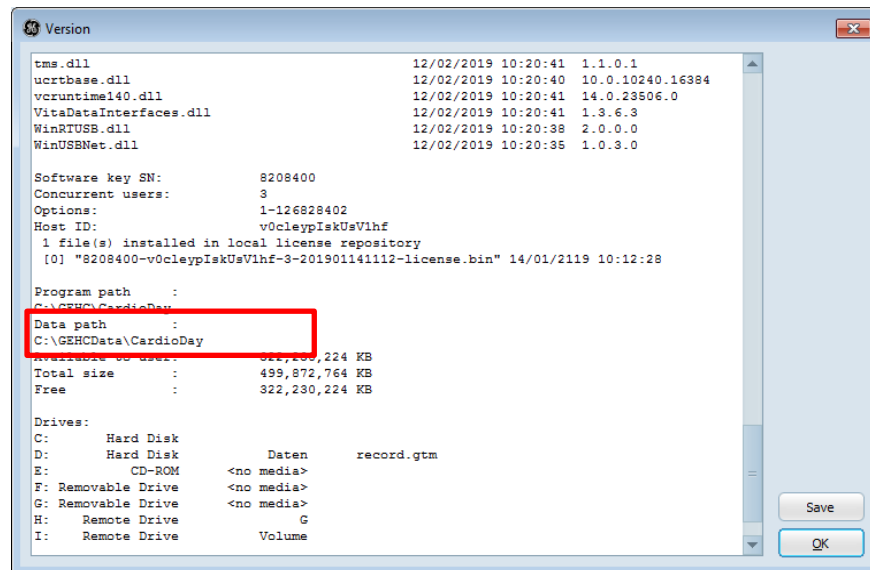
12-channel tab > Marker Setup

For additional information, refer to "[Setup > 12-channel markers...](#)" on page 242.

Automatic creation of markers

With the aid of the file AutoCreateMarker.txt in the data directory of CardioDay, you can automatically create markers while downloading the 12-channel recording.

To locate your data path, select **Help > Version** and find the **Data path** variable near the bottom of the window.

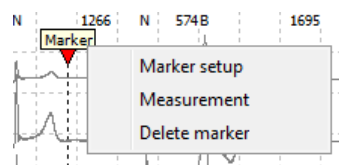


CardioDay data directory in the Help > Version sub-menu

For additional information, refer to “[Extras > Create 12-channel markers...](#)” on page 222.

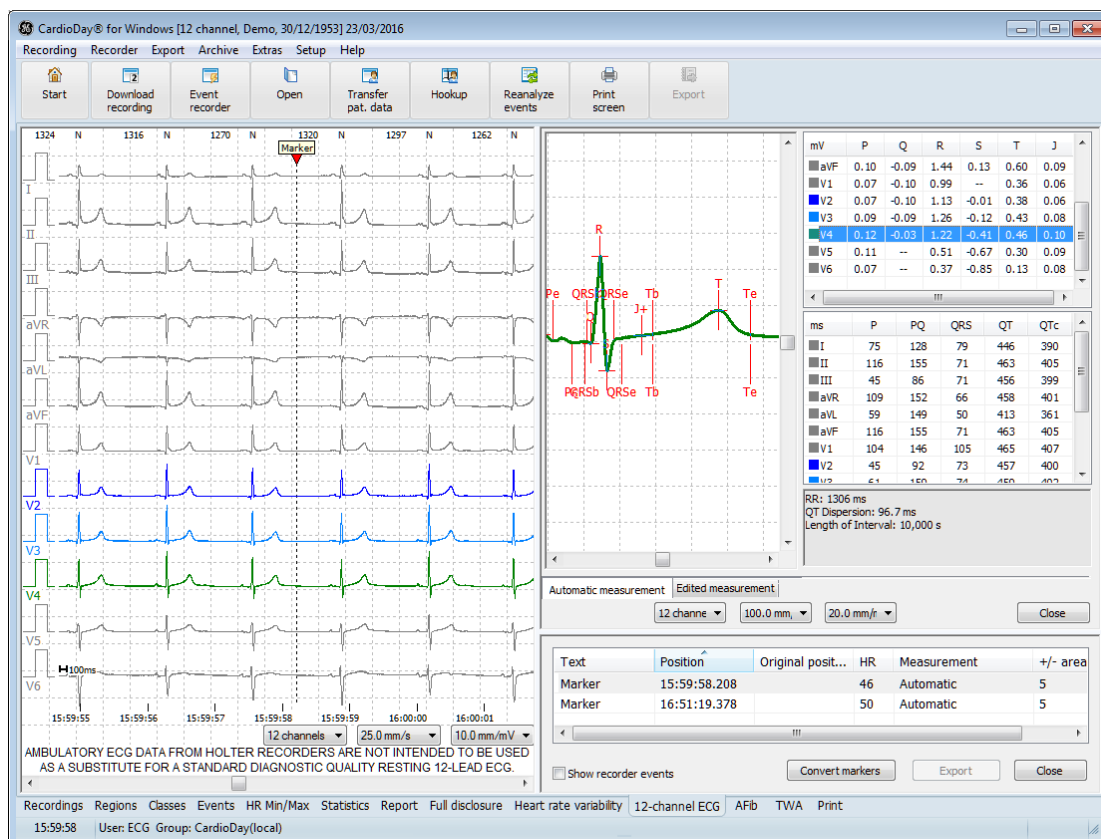
Automatic Measurement

Right-click on the marker to access the **Measurement** context menu. Placing the mouse pointer over the menu changes the display to blue. Clicking on Measurement will open a window with the measurement area for single beats and the channel list.



12-channel tab > Measurement

The channel list displays the automatically determined measurement results on the right. If you click on a channel, the selected channel is highlighted to facilitate evaluation. If you double-click on a channel, only the selected channel is displayed.

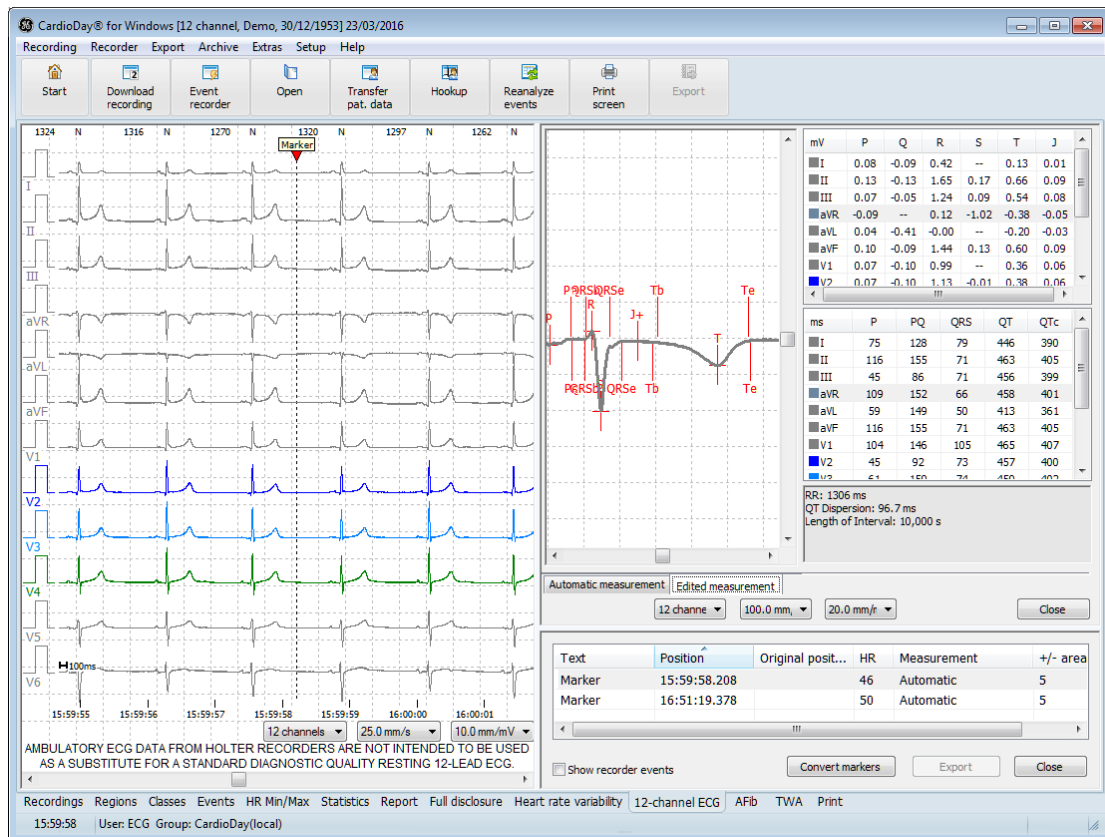


12-channel tab, automatically generated values for the channel V4

Editing the automatically generated values

After the automatic measurement, you may edit the generated values, if required. When you click the **Edited measurement** sub-tab, all the values are copied and the original values are saved.

The 12-channel ECG tab



12-channel tab, edited values

By clicking a row in the table of measurement values, the corresponding channel is displayed highlighted and the corresponding values marked. The vertical line above the zero line on the ECG display are related to highlighted single channels, and the vertical lines below the zero line are related to the averaged results of the evaluated QRS complexes. Using these lines, you can carry out the following editing functions:

1. To correct a measurement point, click the vertical line marking the measurement point and move it using the mouse.
2. If a measurement point cannot be generated automatically, right-click on the respective spot and select the function in the context menu.

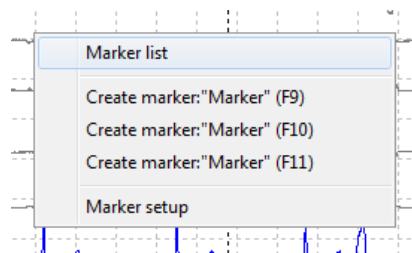
Convert marker / Show recorder events

By left-clicking the button **Convert marker**, you convert event markers into regular 12-channel markers.

By left-clicking the button **Show recorder events**, you get—in addition to the other events—a list of events either manually marked by the patient with the **Enter** key of the recorder or automatically marked by the device.

Export of ECG sections, the Marker list

Right-click on the ECG to open a context menu. To export data, go to the **Marker list** menu.



12-channel tab > Marker list

Every marker created within the recording is shown on the displayed list. Select one or several markers and left-click the **Export** button.

An XML file will be created and stored under the pre-set path. To activate the 12-channel marker export, a specific entry in the CardioDay.ini is needed with the corresponding setup configurations. For more information on the setup, refer to the *CardioDay V2.5 Installation and Field Service Manual*.

16

The Respiration tab

NOTE:

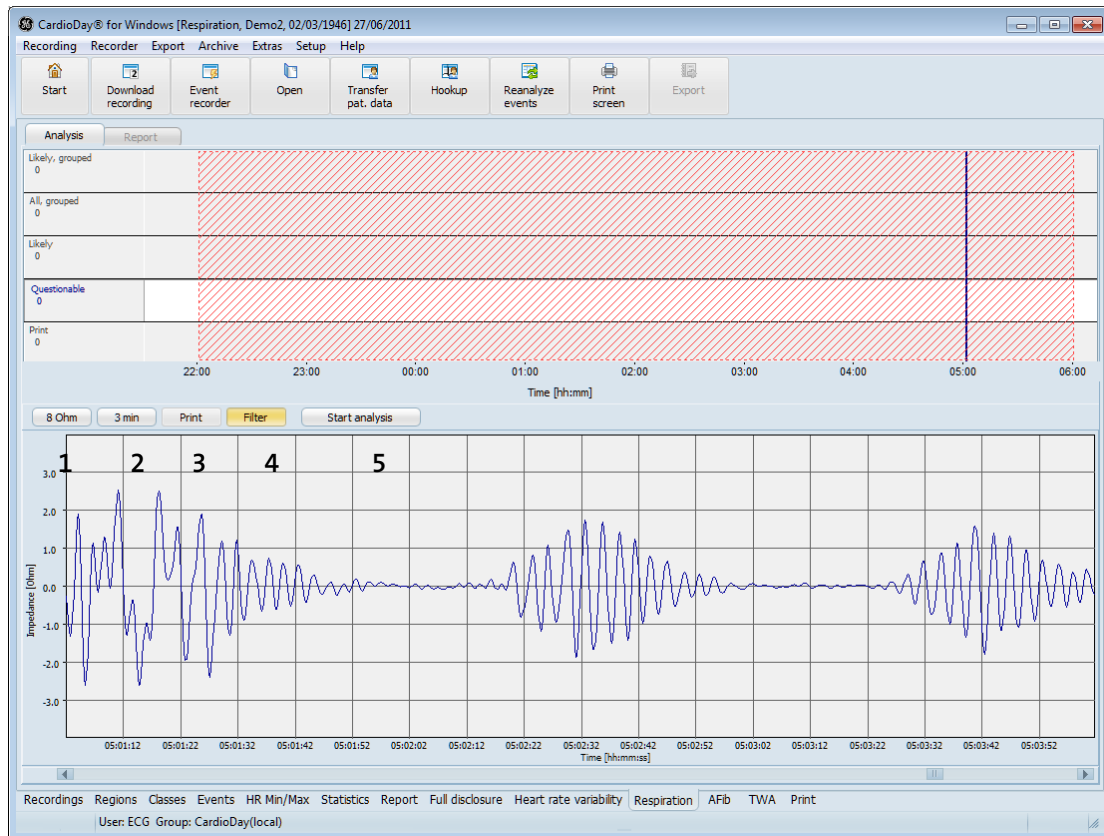
The **Respiration** tab is available only for specific recorders and recordings where respiration was recorded.

On the **Respiration** tab:

- the respiration analysis will be started if it was not performed earlier,
- the results of the analysis will be displayed by interpreting the signal of impedance changes, and
- the report of the respiration analysis can be separately printed.

The Analysis sub-tab

If the respiratory signals of the recording have not yet been analyzed, the period to be analyzed is shown as a shaded area. If the respiratory signals of the recording have already been analyzed, the results are immediately displayed.



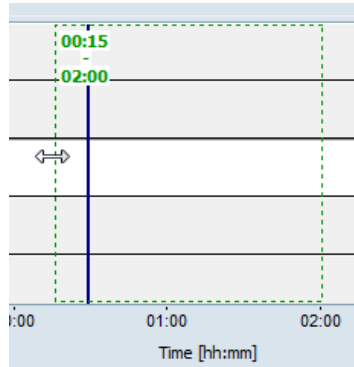
Prior to analysis

The following analysis status information is displayed in the status bar of the **Analysis** sub-tab:

1. Amplitude of impedance axis. (This can be altered with left-click to 0.2, 0.5, 1, 2, 4, 8, 16, or 32 Ohm.)
2. Time axis setting. (This can be altered with left-click to 1, 2, 3, 5, or 10 minutes.)
3. Display of whether the current event has been highlighted for printing. (This can be altered with a left-click.)
4. Filter setting. (Using the **Filter** button, you can display the respiratory curve as filtered or unfiltered.)
5. Button to start or cancel the analysis.

Specification of the analysis period

The period of night sleep is better suited for the respiratory analysis. You can specify the desired analysis period by moving the dashed start or end marking with the mouse while holding down the **Ctrl** key. The markings may be set in 15-minute intervals.



Specification of period for the respiratory analysis

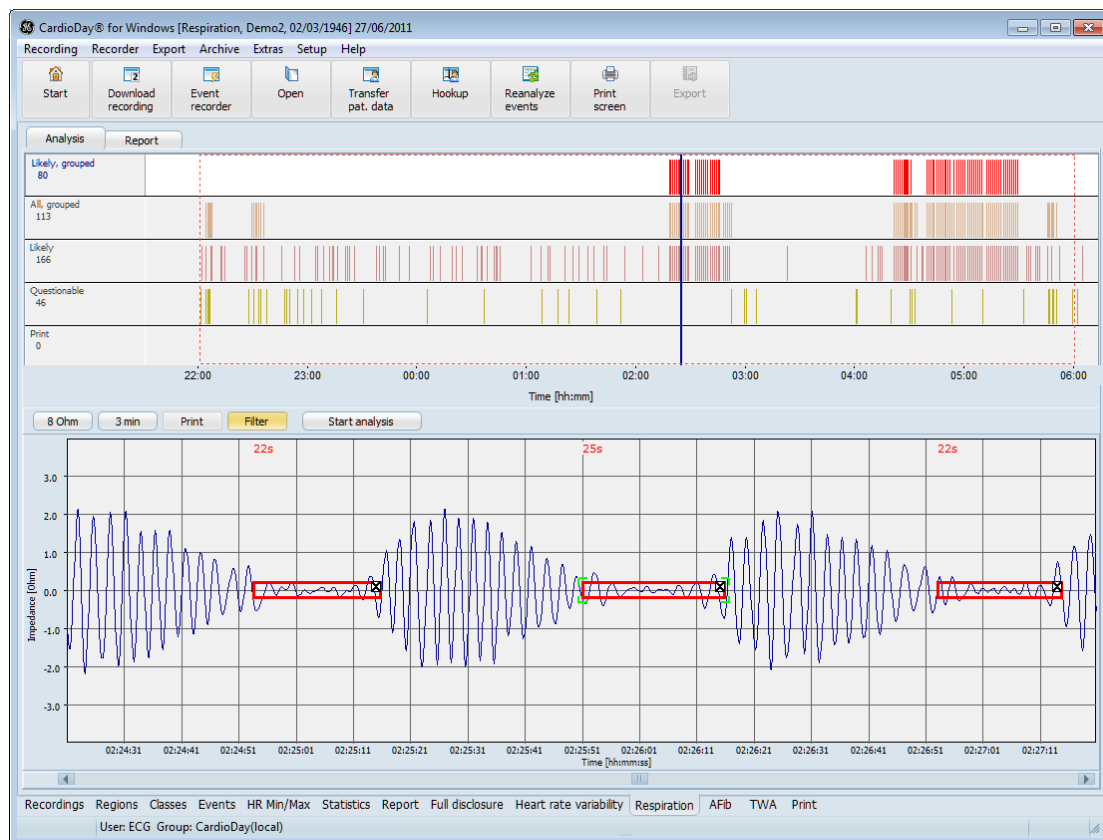
Start of analysis

Start the analysis by left-clicking on the **Start analysis** button.

During the analysis, its progress is displayed as a percentage and the period under analysis is shown within a dashed frame.

If you click on the **Cancel analysis** button (previously **Start analysis**), results will only be available for the period already analyzed.

Evaluation and correction of the results of the respiratory analysis



Results of the respiration analysis

The results are displayed when the analysis is complete.

NOTE:

It is essential that a physician manually validate the CardioDay respiratory analysis before the results are used for diagnostic purposes.

The upper part of the window displays an overview of the respiratory irregularities (episodes) detected.

The episodes are presented as a histogram at a position that corresponds to the time at which they occurred. A group is defined as more than 3 episodes occurring within 90 seconds of each other.

The boxes marking the episodes of a group are drawn with wider lines than those of individual episodes.

Episode label	Description
<i>Likely, grouped</i>	Episodes recognized as probable, occurring in groups.
<i>All, grouped</i>	Episodes recognized as probable or questionable, occurring in groups.
<i>Likely</i>	Episodes recognized as probable.

Episode label	Description
Questionable	Episodes recognized as questionable. These can be reclassified as Likely episodes by left-clicking in the detailed view.
Print	Episodes marked to be printed.

You can sequentially go through the episodes individually by pressing **Enter** after each episode. To go backwards, press **Backspace**.

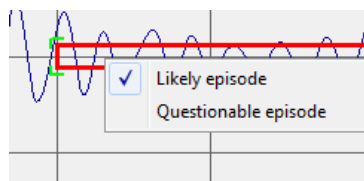
A highlighted episode can be deleted pressing **Delete**.

The lower part of the window displays a detailed view of the section marked with a line in the detailed overview.

The detailed view contains the respiratory curve as well as the **Questionable** and the **Likely** episodes detected, highlighted in yellow and red respectively.

You can select an episode by clicking on the yellow or red box. You can delete a selected episode by clicking the box with the x inside or by using the **Delete** key.

While holding **Shift+Ctrl** simultaneously, you can create a new episode by left-clicking and dragging the mouse.



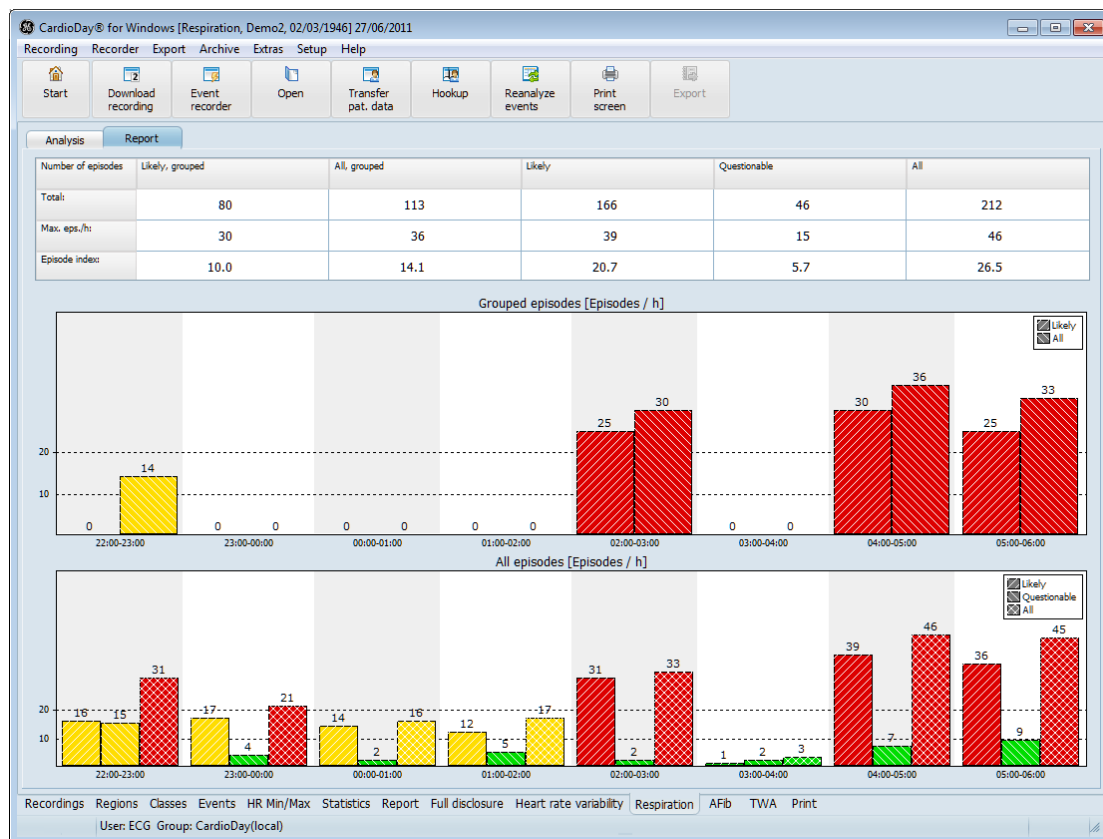
Reclassification in the context menu

A right-click will open a context menu in which it is possible to reclassify an episode.

The Report sub-tab

The report shows the results of the analysis in tabular and graphical forms.

The Respiration tab



Report of the respiration analysis

The report contains the following information for **Likely, grouped**, **All, grouped**, **Likely**, **Questionable**, and **All** episodes:

- the total number of episodes,
- the maximum number of episodes within a one-hour period, and
- the episode index, which is the total number of episodes divided by the number of hours of the analysis period.

The upper graph shows the number of **Likely, grouped**, and **All, grouped** episodes for every hour of the analysis period.

On the basis of the lower graph, it is possible to compare the following different episode classes quantitatively:

- all likely episodes
- all questionable episodes
- all detected episodes

The bars are color-coded as follows:

- green, when number of episodes per hour is fewer than 10
- yellow, when number of episodes per hour is between 10 and 19
- red, when number of episodes per hour is 20 or more

17

The AFib tab – Frequency analysis for detection of atrial fibrillation

NOTE:

In the case of an ECG with pronounced muscle artifacts or where there is a low signal-noise ratio, e.g., with low P waves, it is not possible to analyze the fibrillation frequency.

If in doubt, check the result of the QRS cancellation in the bottom-left window and the detected fibrillation frequency in the bottom-right window in the respective ECG section.

On the **AFib** tab, it is possible to carry out an analysis in selected 5-minute ECG sections in order to estimate the atrial fibrillation frequency. You are free to select the time point at which the respective ECG section should begin.

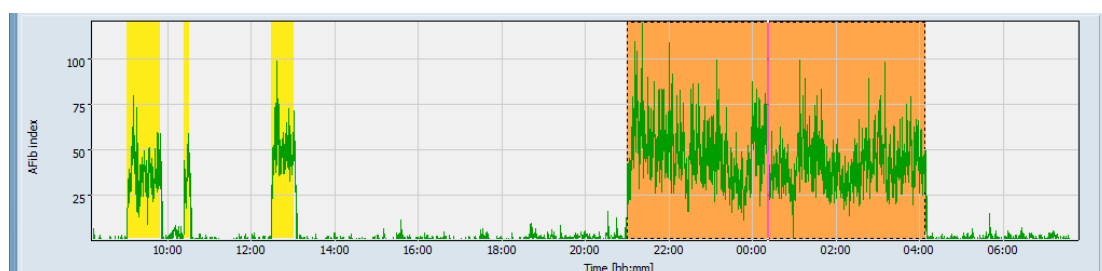
The AFib tab – Frequency analysis for detection of atrial fibrillation

The first step is to perform QRST cancellation to remove ventricular activity (e.g., QRS complex and T wave) as much as possible from the ECG. The fibrillation frequency and cycle length of the fibrillation waves are then determined by means of Fourier analysis.



The AFib tab

Like the **AFib** sub-tab of the **Statistics** tab, the ECG sections with possible indications of atrial fibrillation are displayed in the upper part of the screen.

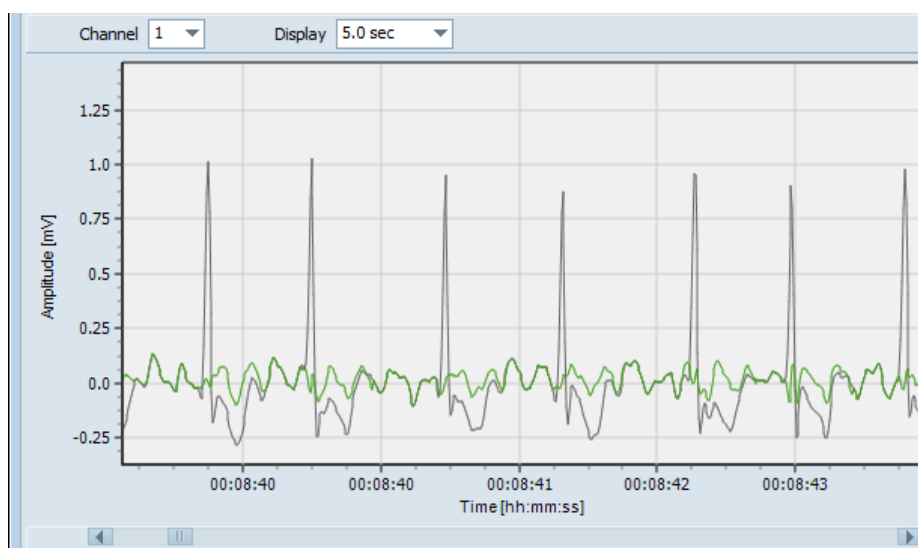


Display of ECG sections with possible indication of atrial fibrillation

The red line indicates the time at which the current frequency analysis begins. You can initiate a new frequency analysis by left-clicking on the desired starting time. The QRST cancellation and subsequent frequency analysis are performed automatically.

You can select the channel for the frequency analysis from the relevant menu bar.

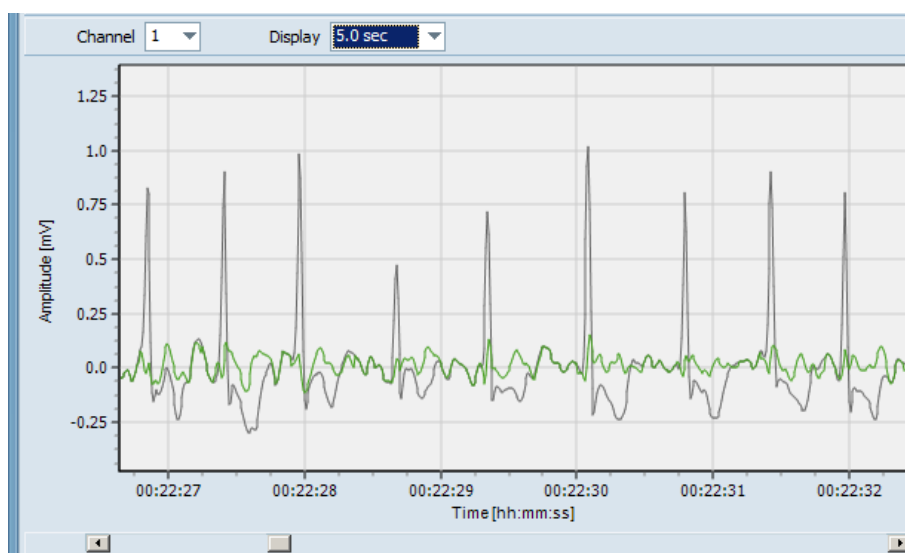
As a result of the frequency analysis, the bottom left-hand part of the screen displays the ECG signal after QRST cancellation in a dark color and the complete original ECG in a light color. You can right-click to hide or display the ECG.



Result of the frequency analysis

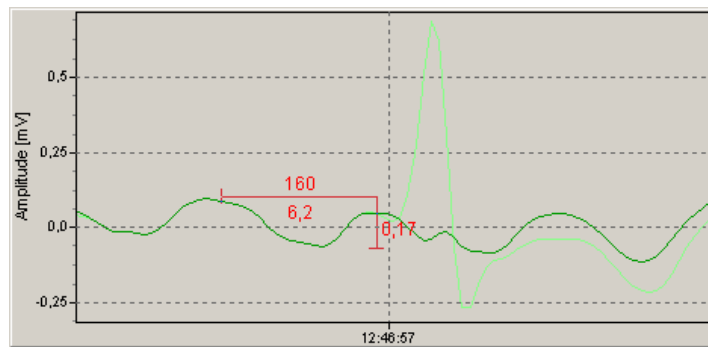
By dragging a rectangle from top left to bottom right with the mouse, you can magnify the displayed section. If you briefly drag the mouse from bottom right to top left, the whole interval is displayed again.

You can also set the period for the section in the bottom left part of the screen to a value less than 5 minutes in the menu bar.



Results of the frequency analysis, display of 5 seconds of the ECG section

By holding down the **Ctrl** key and dragging the mouse, you can measure the ECG manually. The display shows the duration in milliseconds, the fibrillation frequency in Hertz, and the amplitude in millivolts.

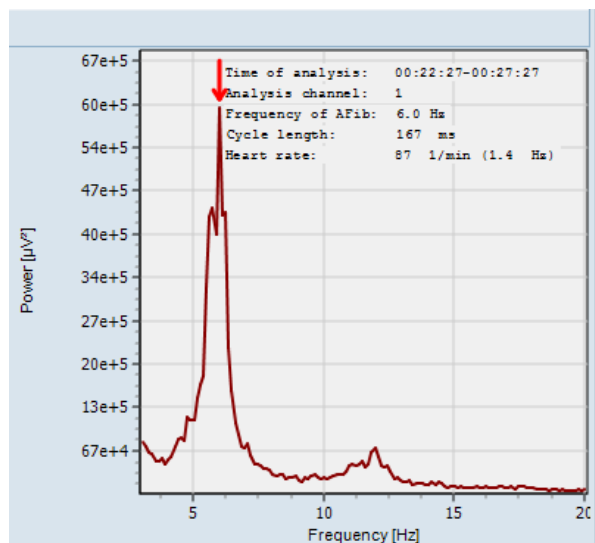


Measuring the ECG

To delete a measurement, hold down the **Ctrl** key and left-click on the measurement line.

In the lower right-hand part of the screen, the fibrillation frequency is displayed in Hertz and the corresponding cycle length of the fibrillation waves in milliseconds. The mean heart rate is also shown in beats per minute and in Hertz.

The spectrum calculated after the QRST adjustment shows the frequency distribution of the atrial activity. The dominant fibrillation frequency is identified with a red arrow at the most prominent peak in the spectrum.



Results of the frequency analysis as a spectrum

You can subsequently change this frequency by dragging the mouse. The values for the fibrillation frequency and the cycle length are automatically changed in the top right-hand part of the screen.

18

The TWA tab – T Wave Alternans

The **TWA** tab provides a T Wave Alternans analysis of the complete ECG recording. This reveals beat-to-beat differences in the morphology of the ST area and T wave.

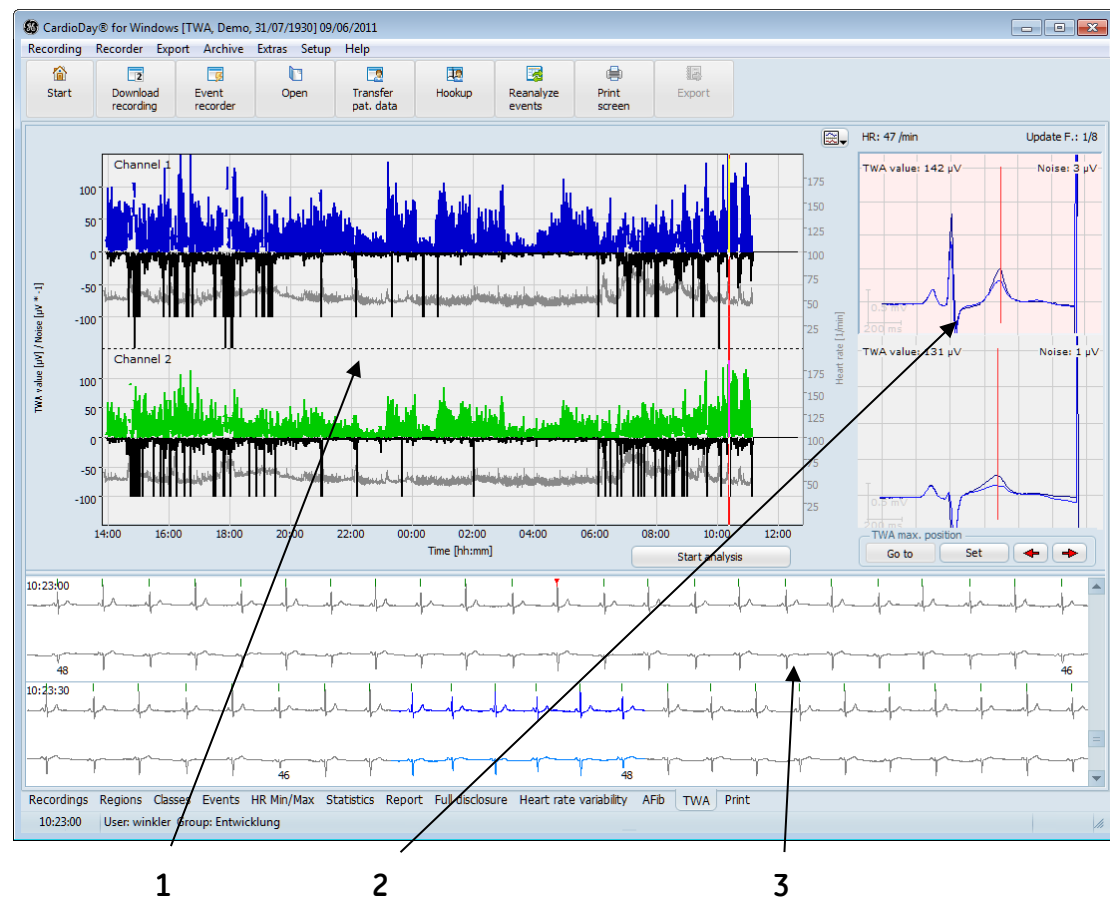
The beat annotation distinguishes them as even or odd beats.

Screen layout and operation

On the TWA tab, you find windows for the following analysis results:

- the calculated TWA data, the values for noise and heart rate, each displayed graphically in window 1
- the averaged even and odd beats in window 2
- the ECG in window 3 for the position selected on the time axis in window 1

The TWA tab – T Wave Alternans



The TWA tab

The calculated data are displayed for every channel selected for analysis.

The TWA and noise data are calculated with a temporal resolution of 10 seconds. Both values are shown in μV . The noise value is displayed as a negative value to provide a better readability.

The heart rate is shown on the right-hand side of the graph in beats per minute. The position currently selected is displayed as a red vertical line.

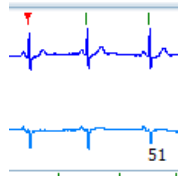
For every channel, the averaged even and odd beats are displayed to the right of the TWA curve in an overlapping manner in window 2.

The beats shown in window 2 are the moving average over all beats up to the position of the red line in window 1.

In addition, the TWA value measured up to this time, as well as the value for noise and heart rate, is displayed numerically.

The positions of the largest deviations between the even and odd beats in the ST and T areas are displayed by red vertical lines in window 2.

Window 3 shows one minute of ECG section around the selected time position on the TWA curve.

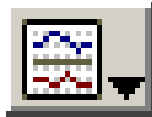


Marker shows end of 10-second period over which TWA value is calculated.

A red marker in window 3 shows the end of the 10-second period corresponding to the red vertical line in window 1.

Select analysis channels

You can select a maximum of 4 channels via the channel selection symbol.



Channel selection button

Start analysis

Click the **Start analysis** button. Any earlier analysis data are overwritten.

While CardioDay is performing the analysis, the TWA curves, together with the even and odd beats, are updated on the screen at regular intervals. The analysis progress is shown by a red vertical line.

If you click the **Stop analysis** button, the data calculated up to this point will be displayed.

The analysis results are saved automatically.

Evaluation and correction of the TWA analysis

NOTE:

Although the TWA algorithm checks the analysis results for plausibility, the TWA values calculated automatically must not be used for diagnostic purposes before they have been validated by a trained physician or healthcare professional experienced in Holter ECG and TWA analysis.

The **TWA** tab in the **Setup > Other options** menu provides the possibility of setting the following analysis parameters

- **Update factor**
- **Heart rate threshold**
- **Noise threshold**

Once the analysis is complete, the red vertical line is automatically positioned at the time of the highest TWA value. By clicking the TWA curve, you can select another time position.

If you wish to select the time of the highest TWA value again, click the **Go to** button in the **TWA max. position** screen area underneath window 2.

If it should be necessary to select another position for the highest TWA value, select the new position in the TWA curve and then click the **Set** button in the **TWA max. position** screen area.

The selected maximum TWA position also determines the position for the TWA ECG printout.

Valid and invalid TWA values

The plausibility of the calculated values is checked by the analysis algorithm. Among other factors, heart rate and noise are crucial for the reliability of the analysis.

The TWA curve only shows the values presumed as valid. The curve shows a gap if values are not plausible.

Invalid TWA values among the even and odd beats are displayed with the value “-1” in window 2.

19

The Episodes tab – evaluation of episodes imported from an event recorder

NOTE:

Event episodes that have been recorded using the CardioMem CM 3000 L3 recorder are not downloaded directly from the recorder but they are imported. For further information, please refer to the section “[Recording > Import...](#)” on page 201.

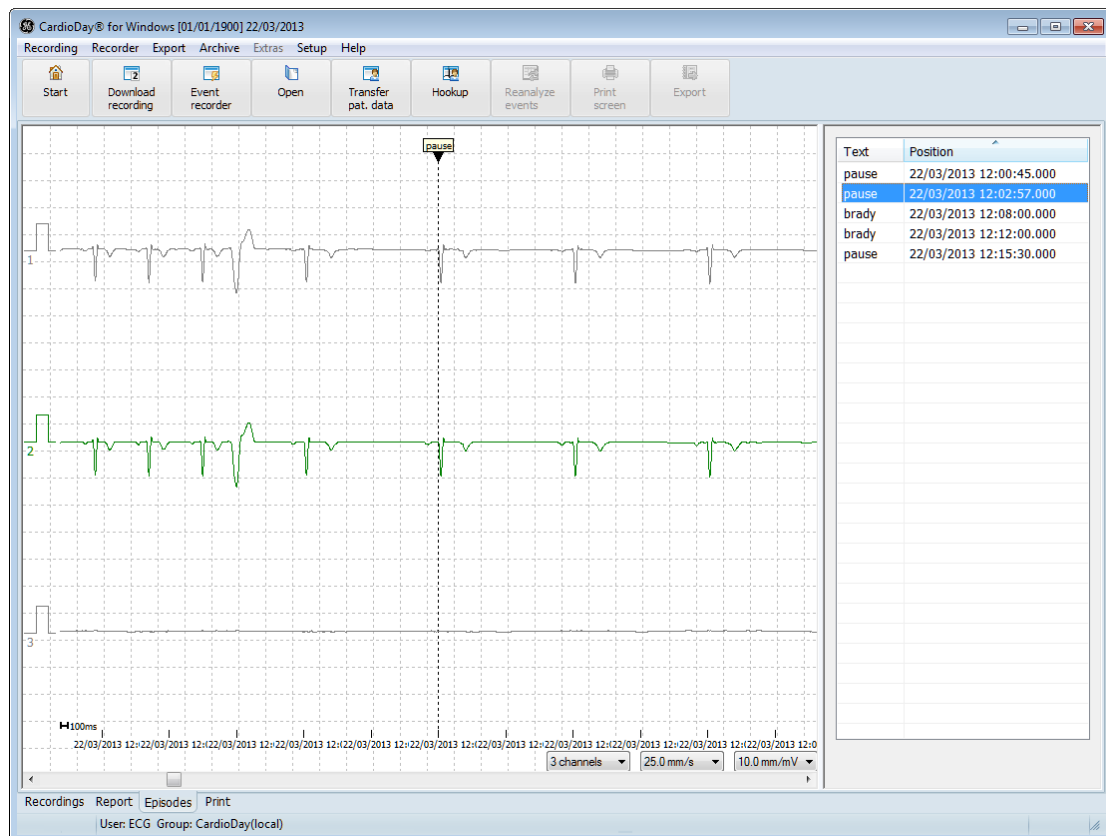
This tab is only available after opening episodes recorded with an event recorder.

On the right, the event episodes are listed together with their time and date of occurrence. The event recorder can detect bradycardia, tachycardia, atrial fibrillation, and pauses. In addition, the recording of episodes can be activated manually as well.

On the left, the ECG episode currently highlighted is displayed together with its pre- and post-event times set in the event recorder.

The Episodes tab – evaluation of episodes imported from an event recorder

The vertical line shows the time at which the event was detected.



The Episodes tab

To select several episodes for printing, hold the **Shift** key (for consecutive items) or the **Ctrl** key (for non-consecutive items) and click the entries in the list.

Proceed as follows in order to measure a waveform section.

Keeping the **Ctrl** key pressed down, left-click on the point at which you want the measurement to begin and then click on the point at which the measurement should end.



Measurement of waveform sections

To delete the measurement, right-click on the measuring line and select this function from the context menu.

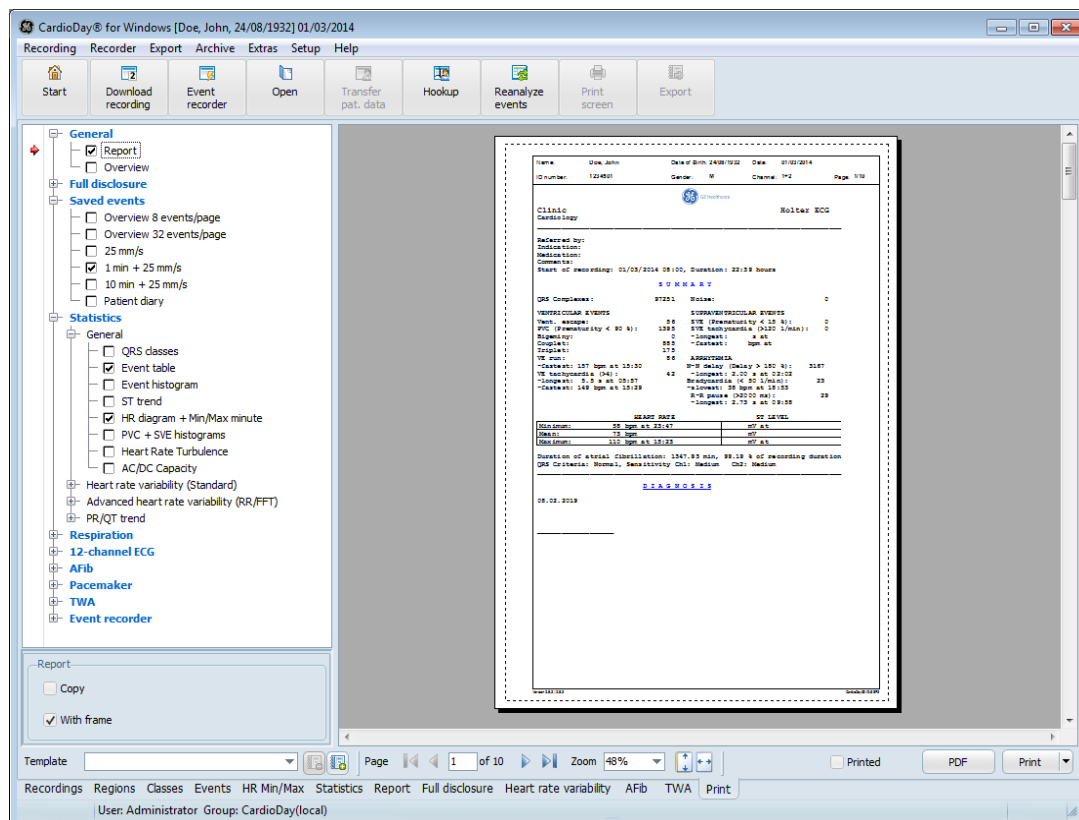
20

The Print tab

In the print preview, you can examine and, if desired, select a multitude of printouts.

Each of the options available generates a precisely defined printout, which always has the same layout, resolution, and structure. This allows a quick review and evaluation of the printouts. The heart rate over time is required as a comparative value in several of the options and, therefore, printed several times (in **Overview**, **Event histogram**, **ST trend**, **Heart rate variability**, **PR trend**, and **TWA**).

The individual printing options are described in the following sections.



The Print tab

Selecting a printer

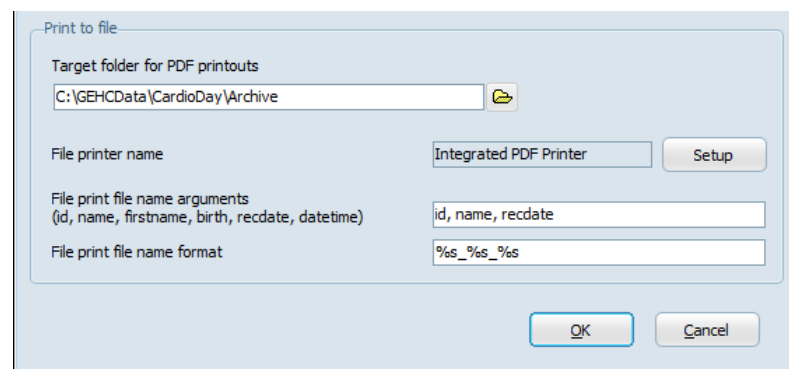
If you click the **Print** button, you create your printout on the Windows default printer.

You can select a different printer as explained in the “[Setup > Printer...](#)” section on page 243. Here, you can select all printers configured in your Windows installation.

You may also temporarily select one of the available printers by clicking the black triangle next to the **Print** button.

Configuring a PDF file destination

If an appropriate printer driver has been installed, CardioDay also generates files in PDF format.



Setup > File path, file print settings

If a printer file path has been selected, a button labeled **PDF** is displayed to the left of the **Print** button on the **Print** tab.

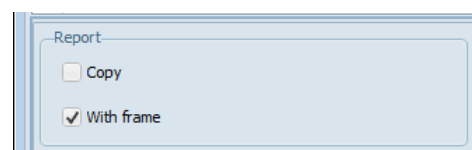
For information about file names and supported printer drivers, refer to the *CardioDay V2.5 Installation and Field Service Manual*.

Default and customized print selection templates

The content of the report files depends either on the print selection saved for each recording or on the current defaults.

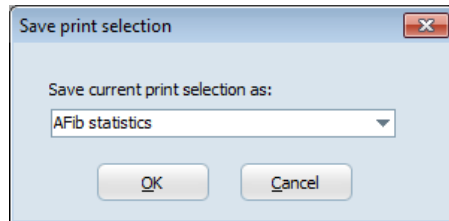
At first opening, a recording will have the default print selection which you can edit and save. For all new recordings, again the default print selection will be displayed.

To customize separate print selections, you can create and edit your own print selection templates, which you can afterwards select from a dropdown list.



Print tab, print selection

If you selected additional printouts or removed printouts from the default print selection, the **Template** field at the bottom will be blank and you can enter the name of your new print selection. If you click the **+** symbol next to the **Template** field, a window opens for entering your name for the current print selection.



Field for naming and saving a customized print selection template

If no template is displayed in the list, the chosen print selection does not match any existing template. If the recording is reopened, it will have the print selection set last. Saved templates can be deleted anytime by pressing the **-** key or clicking the **-** symbol next to the **Template** field.

NOTE:

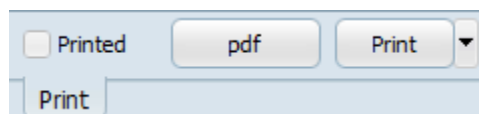
The **Default** print selection template cannot be deleted.

Printed check box

Generally, the evaluation of a recording will be considered complete once the report is **Printed** or stored to a **MUSE** system.

Status indicators like **Printed** or **MUSE** are shown in the **Status** column on the **Recordings** tab. See [“The Info and Status columns”](#) on page 46 for information on status indicators.

To change the recording's status to **Printed**, first set the **Printed** checkbox and then click **Print**. The **Status** column for this recording on the **Recordings** tab will change to **Printed**. Printing the report without setting the checkbox will not update the recording's status. Setting the checkbox without printing the report has no effect.



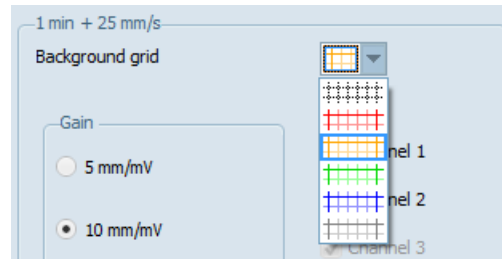
Print tab, Printed checkbox

You can select an alternate print destination other than the configured default from the available Windows print destinations by clicking the black triangle next to the **Print** button (see also [“Selecting a printer”](#) on page 154).

You can also generate a PDF file to the default/configured PDF print file location by clicking the **PDF** button (see also [“Configuring a PDF file destination”](#) on page 154). This will add the **PDF** status indicator to the **Status** column for this recording of the **Recordings** Tab.

25 mm/s ECG strip settings

You can adapt the background grid for the 25 mm/s ECG strips. There are 6 different color configurations available that you can select from a drop down menu.



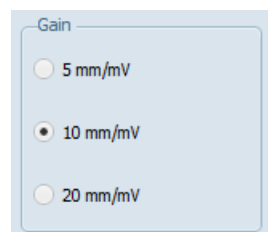
Background grid settings

You can also select the sorting criteria of the strips. If you select **By type**, the strips will be displayed in the same hierarchical order as in the events tab. If you select **Chronological**, all saved strips will be displayed in chronological order.



Sorting settings

Furthermore, you can change the amplitude scales for the displayed channels.



Amplitude scale settings

General > Report and Overview

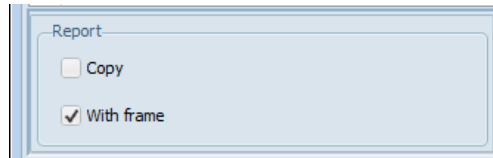
You can select to print a **Report**. A report consists of the automatically generated summary and your diagnosis.

If you use the MUSE Cardiology Information System, you can select the option **Exclude diagnosis on printed report** as explained in "[Setup > Other options > MUSE connection](#)" on page 234. Depending on the setting in **Setup > Other options > MUSE connection > Exclude diagnosis on printed report**, the text entered in the diagnosis section is not displayed in the report that is printed or exported to PDF.

If you deselect **Report**, only the printouts you selected in the print selection are generated. Check **Copy** to print an additional copy of the report component of the print selection.

You can remove the frame that is printed as a default, for example if you want to print on your own forms.

If you want to print your own forms and would like to remove the frame from the **Report** page, uncheck the **With frame** checkbox.



General > Report

The **Overview** option prints out the heart rate diagram, as well as information on minimum and maximum heart rate, on atrial and ventricular arrhythmias, and on Heart rate variability. The overview also contains a maximum of 8 marked events and descriptive text.

Name: **PVC, Demo**
Date of Birth: **30/12/1938**
Date: **11/10/2016**

ID number: **1234503**
Gender: **M**
Channel: **1+2**
Page: **2/19**

Heart rate

Heart rate, recording	Supraventricular arrhythmias	Ventricular arrhythmias
Mean : 89/min	SVES total : 83	(PVC+V.Esc) total: 305
Minimum/min : 01:46 (60/min)	SVES/h max : 10 (21:00)	(PVC+V.Esc)/h max: 49 (11:00)
Maximum/min : 12:44 (121/min)	SVTach total : 0	Bigeminy total : 0
Minimum/short : 01:28 (58/min)		Couplets total : 0
Maximum/short : 14:18 (125/min)		Triplets total : 0
Total duration : 20.27 h		Runs total : 0
Total beats : 104636		VE Tachy. total : 0
Artifact share : 0%		R on T total : 0

Bradycardia and QTc (per minute)	ST analysis (per minute)	Heart rate variability
Pauses > 2000 ms: 0	ST-lev min C1: 04:35 (-0.08 mV)	SDNN : 127 ms
Longest pause :	ST-lev max C1: 18:00 (+0.05 mV)	SDANN : 123 ms
Mean QTc : 450 ms	ST-lev min C2: 17:36 (+0.04 mV)	SD : 38 ms
Min QTc >150 ms : 12:47 (418 ms)	ST-lev max C2: 03:17 (+0.14 mV)	HRV-TI : 17
Max QTc : 00:33 (488 ms)	ST-slp min C1: 02:28 (-0.01mV/70ms)	PNN50 : 2 %
	ST-slp max C1: 12:47 (+0.05mV/70ms)	RMSSD : 27 ms
	ST-slp min C2: 16:26 (-0.02mV/70ms)	SDNNIndex: 31 ms
	ST-slp max C2: 02:52 (+0.02mV/70ms)	SDSD : 26 ms

(Time: 08:40:07)

(Time: 22:07:33)

Normal sinus rhythm as basic heart rhythm.
 First degree atrioventricular block and bundle branch block.
 Very few supraventricular extra beats.
 Some polymorphic ventricular extra beats.
 Three ventricular pairs.
 DDD-(R?)-pacemaker stimulation with rare intermittent atrial undersensing without pauses.

Example of overview printout

Print > Full disclosure

The **Full disclosure** check boxes print the ECG tracing in the resolution of your choice. **Full disclosure** enables you to select from three time scales. Then you can select a channel and one or more periods. You can use the **Adaption** function to adapt the printout to your needs by changing the amplitude.

Full disclosure 1 h/page

Channel 1 ▼ Adaption: 0

from: 25/02/2015 12:42 to: 26/02/2015 08:58

25/02/2015 12:42	25/02/2015 08:58
------------------	------------------

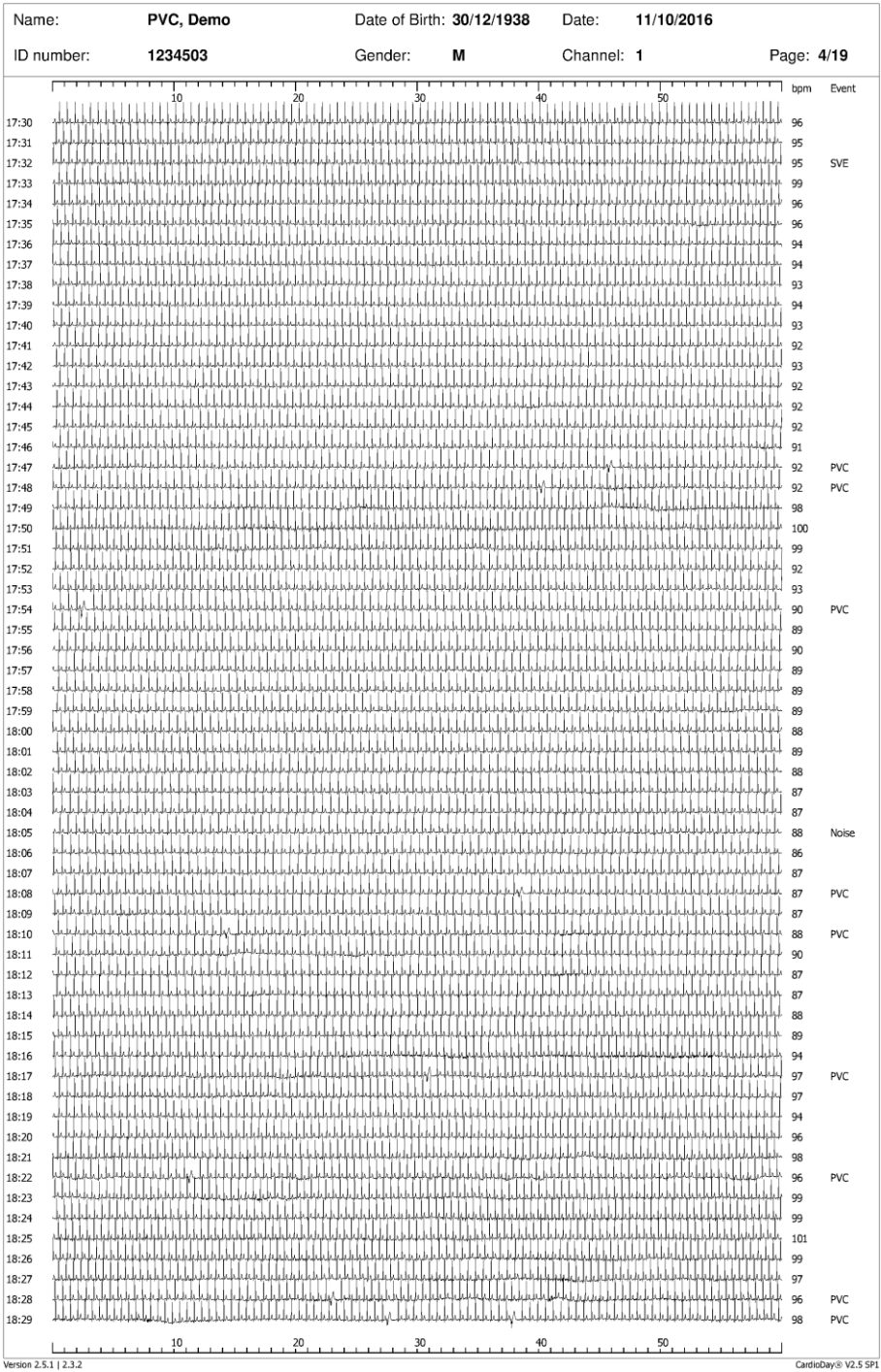
Entries for full disclosure

To add a time period to the list, enter a time period in the **from** and **to** fields and click the **+** button. To delete a time period from the list, select the period in the list and click the **-** button. To select a period for full disclosure printing, select the period in the list and click the disk button; the list will be included in the full disclosure printing.

NOTE:

If you do not set a recording period, the complete recording will be printed. In this case, a full disclosure printout is perhaps time-consuming and can require up to 96 pages per day – depending on the duration of the recording and the resolution.

The printouts have the following appearance:



Sample printout of full disclosure with a resolution of 1 hour per page

The time scales in seconds are displayed above and below the diagram, the time is on the left and the heart rate and most important event for this minute are on the right. The patient event has the highest priority.

Print > Saved events

The options listed under **Saved events** print all events selected for printing using different resolutions and appearance. You can also select the sorting criteria of the strips. If you select **By type**, the strips will be displayed in the same hierarchical order as in the events tab. If you select **Chronological**, all saved strips will be displayed in chronological order.

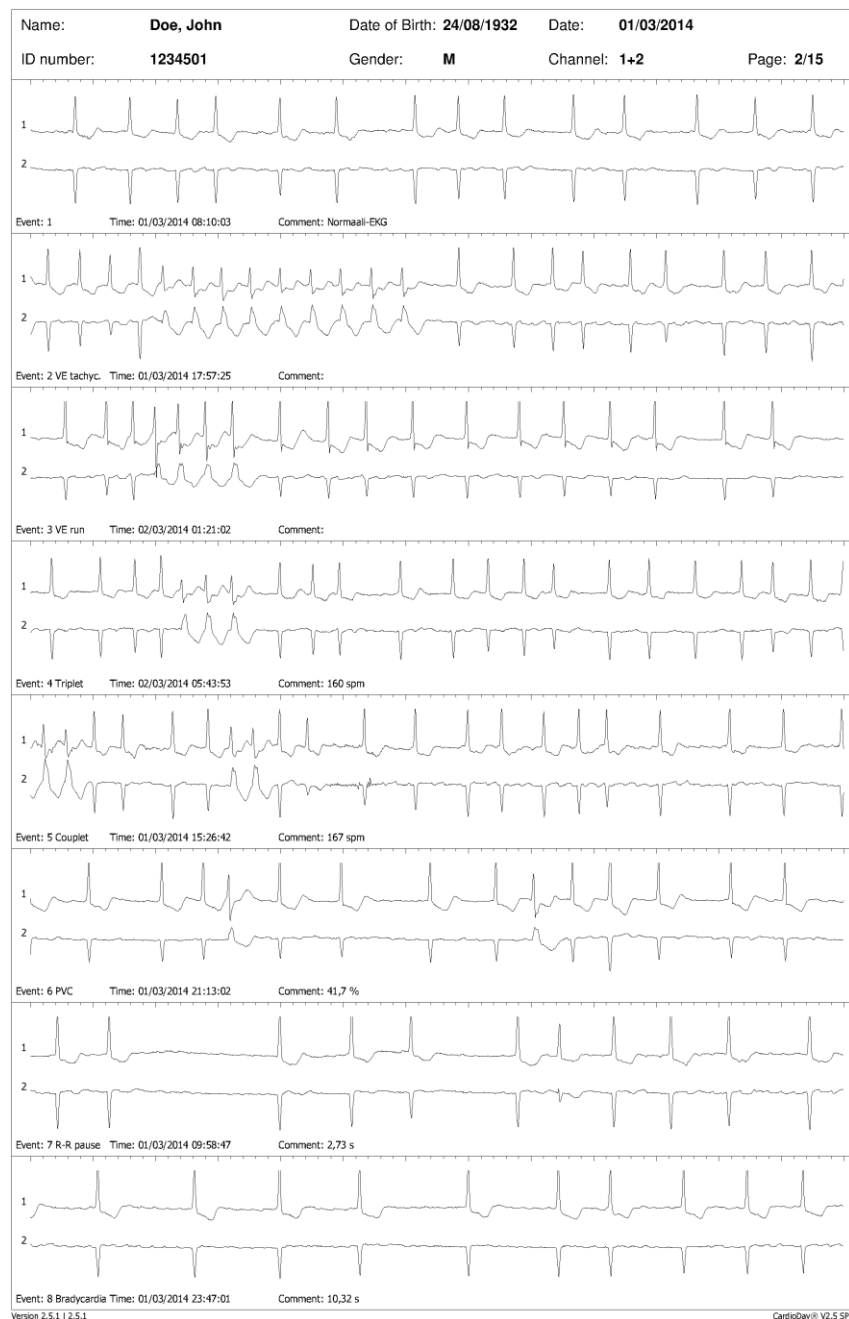
The screenshot shows a software interface for configuring a print job. The 'Saved events' section is expanded, showing options for resolution and appearance. The '1 min + 25 mm/s' option is selected. The 'Statistics' section is also expanded, showing options for data presentation. The 'Sorting' section at the bottom shows 'Chronological' selected. The 'Background grid' and 'Gain' sections are also visible.

Saved events > Selected resolution and channels

You can select the desired channels at the bottom of the **Print** tab.

Saved events > Overview 8 or 32 events/page

Overview prints an easily readable but less detailed summary of events (example for 8 events/page):

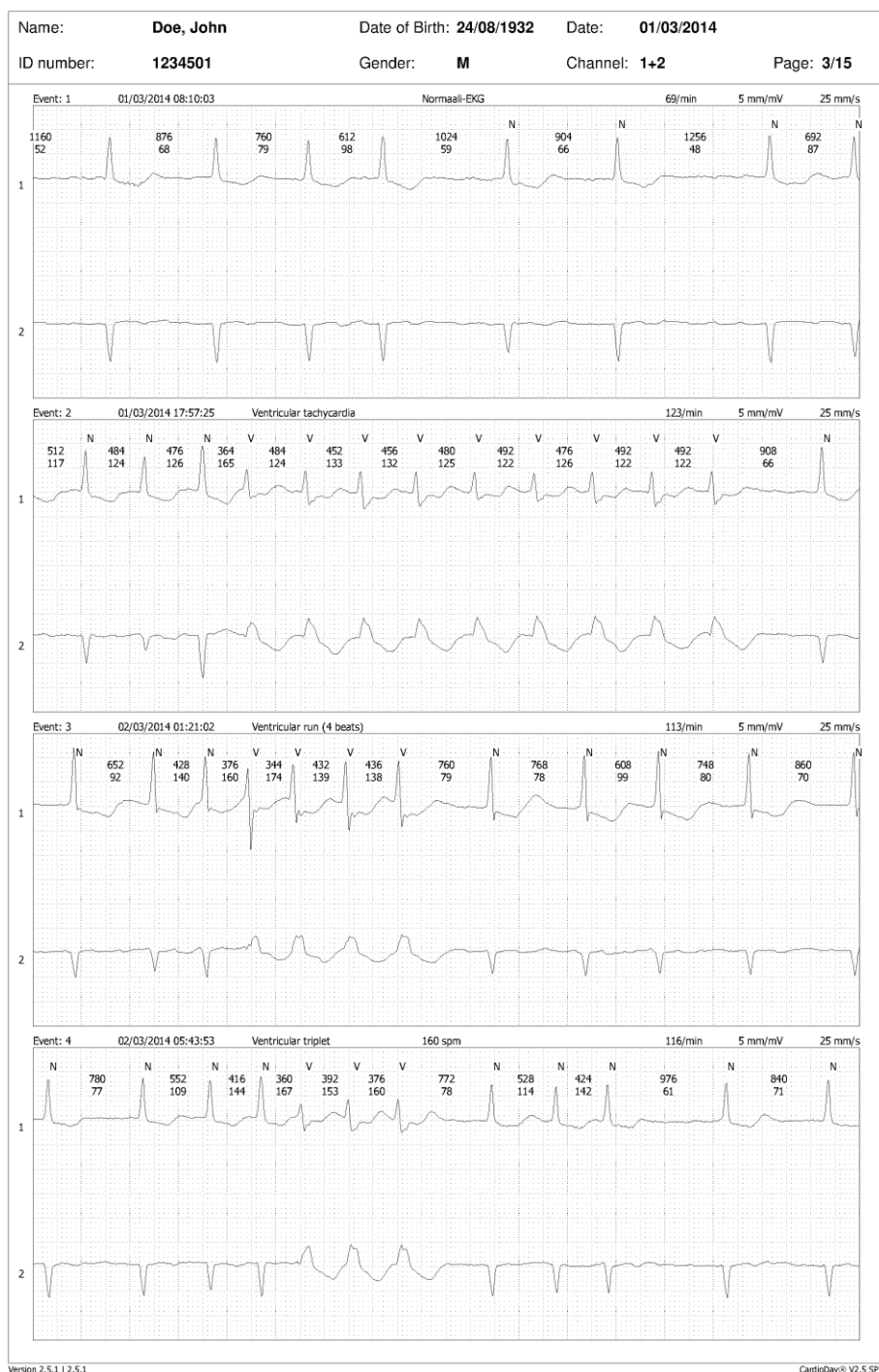


Sample printout of a saved event's overview

Saved events > 25 mm/s

The **Saved events > 25 mm/s** option prints the selected channels for the saved events, but presents them in a magnified form and with additional information.

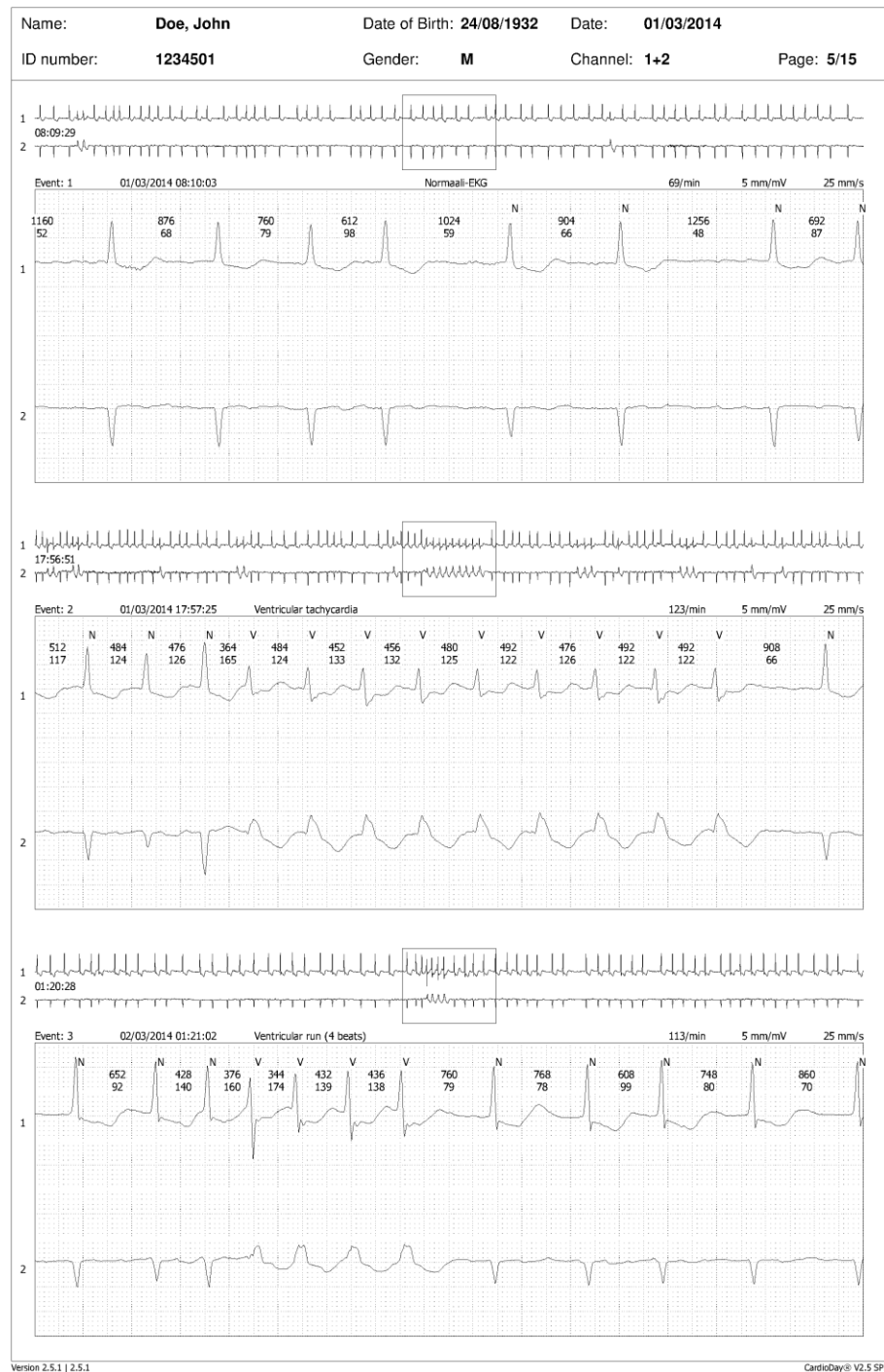
The channel, time of occurrence of the event, and information regarding the resolution are found above each event diagram together with the event's number and type. The diagram itself also shows the QRS classification, the RR interval, and the current heart rate of each QRS complex.



Example of saved events > 25 mm/s printout

Saved events > 1 min + 25 mm/s

Select **Saved events > 1 min + 25 mm/s** to print the same information showing the selected channels:

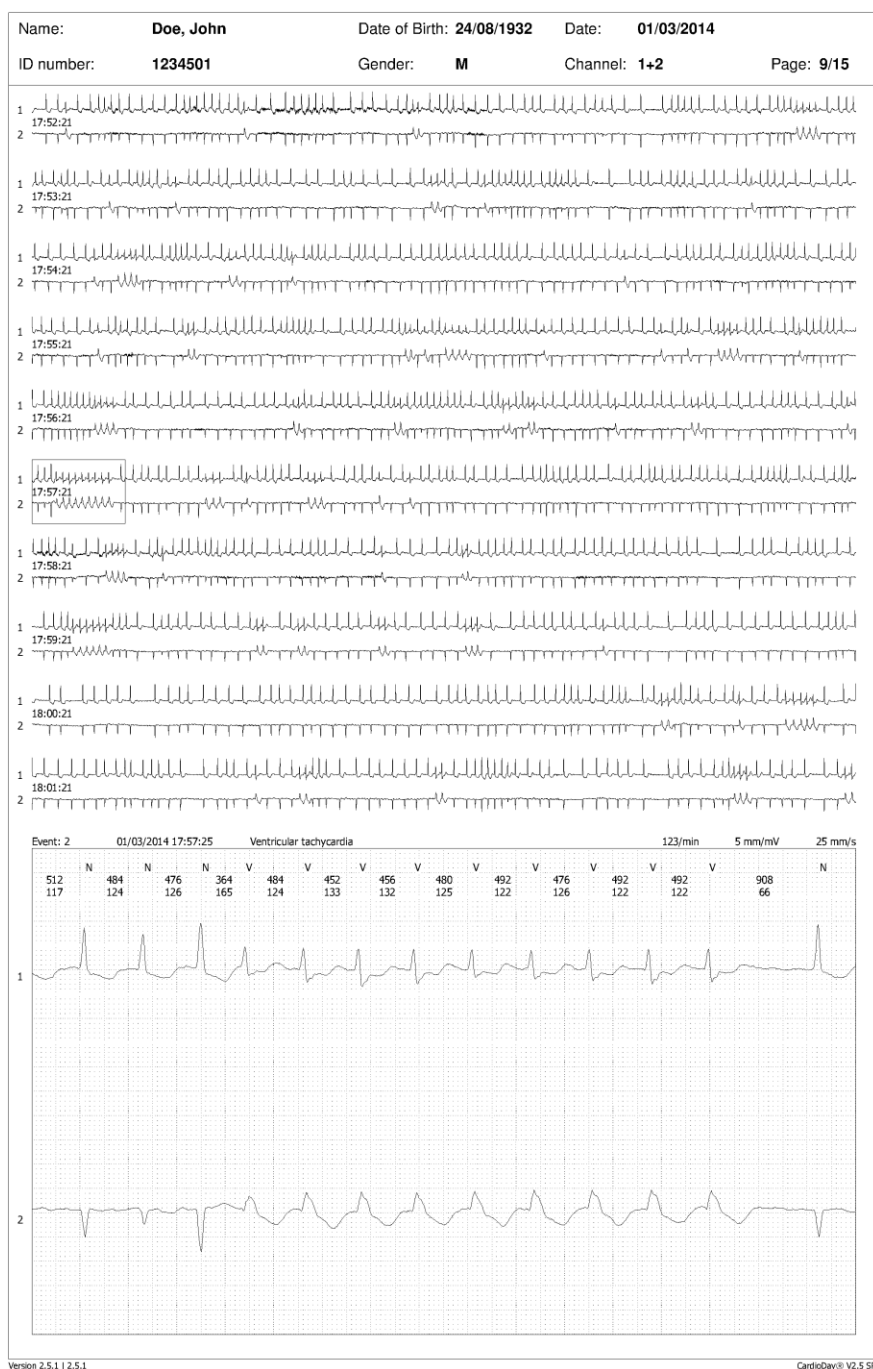


Sample printout of saved events in 1 min. + 25 mm/s display

In addition, one minute of the context of each event is displayed in a lower resolution.

Saved events > 10 min + 25 mm/s

The **Saved events 10 min + 25 mm/s** option prints the selected channels for the saved events.



Sample printout of saved events in a 10 min + 25 mm/s display

Saved events > Patient diary

On the printout of the patient diary, a list with all available patient diary events is displayed. Also, “manual” events are displayed that were marked by pressing the **Event** button at the recorder.

The events are listed in chronological order with the date, time, and comments.

Name:	PVC, Demo	Date of Birth:	30/12/1938	Date:	11/10/2016
ID number:	1234503	Gender:	M	Channel:	1+2
				Page:	5/19
Patient diary					
No.	Date/Time	Comment			
1	11/10/2016 22:07:33	Walking			
2	11/10/2016 22:11:03	Strenuous exercise			
3	12/10/2016 01:18:18	Palpitations			
4	12/10/2016 03:48:34	Dizziness			
5	12/10/2016 04:45:59	Chest pain			

Version 2.5.1 | 2.3.2

CardioDay® V2.5 SP1

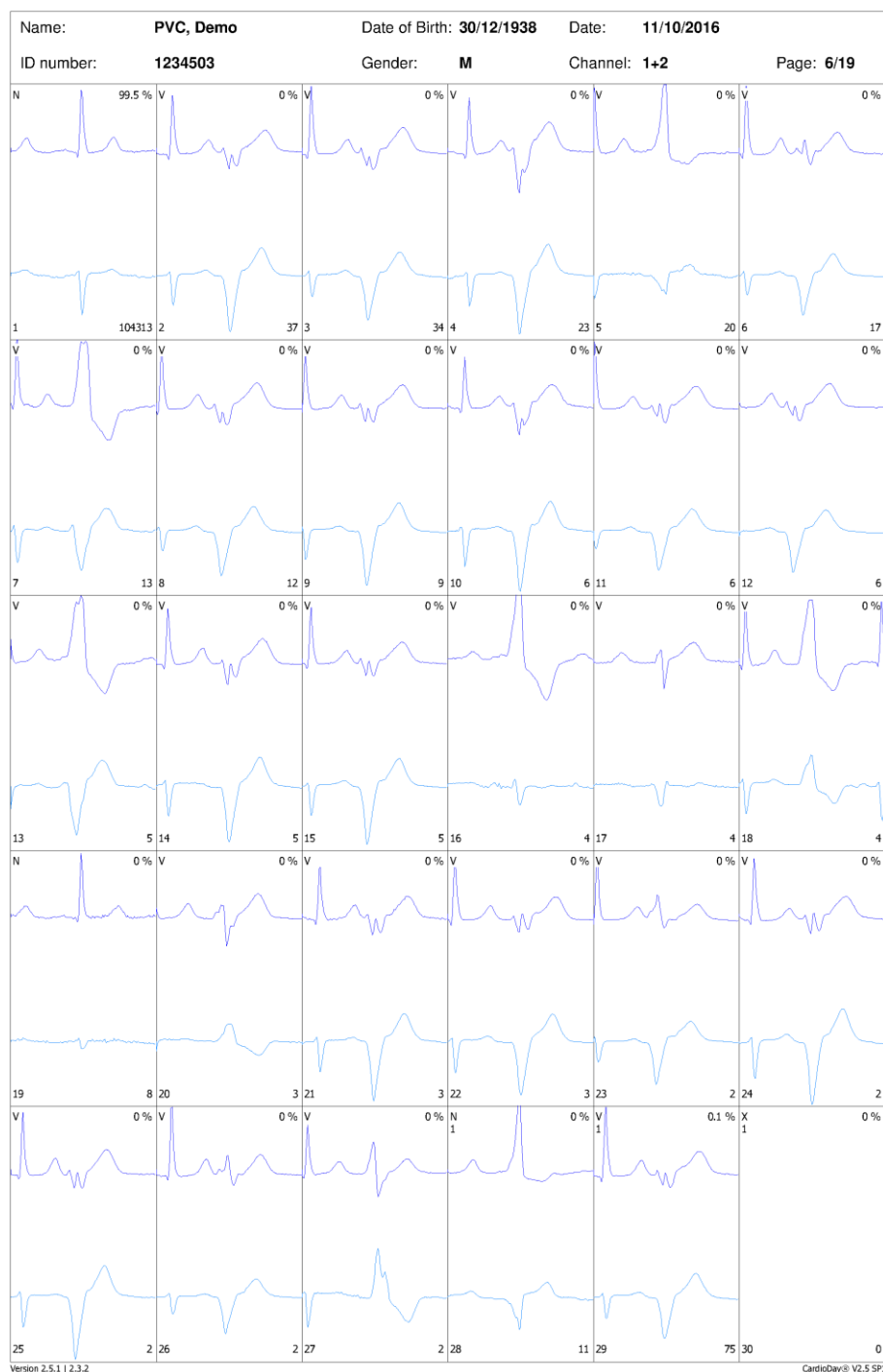
Sample printout of patient diary

Print > Statistics

The options under **Statistics** in the **Print** window document the events found and the results determined on the **Statistics** tab.

Statistics > General > QRS classes

Select **Statistics > General > QRS Classes** to print an overview of the first 30 QRS classes, as displayed on the **Classes** tab.



Sample printout of a QRS classes overview

Statistics > General > Event table

Select **Statistics > General > Event table** to print a tabular summary of all events by hour over the entire measuring period.

Name:

PVC, Demo

Date of Birth:

30/12/1938

Date:

11/10/2016

ID number:

1234503

Gender:

M

Channel:

1+2

Page:

8/19

Table of hourly events

Time	QRS	PVC +V.Esc	BIG	COUP	TRIP	RUNS	VT	SVE PAUSE	BRADY	N-N delay	SVTACH	Heart rate min mean max			NOI	PAT	
08:40																	
09:00	2041	0	0	0	0	0	0	0	0	0	0	100	103	107	0	0	
10:00	6053	17	0	0	0	0	0	3	0	0	1	0	86	101	110	0	0
11:00	4992	49	0	0	0	0	0	5	0	0	32	0	71	85	100	0	0
12:00	5756	20	0	0	0	0	0	0	0	0	0	0	87	96	102	0	0
13:00	5859	48	0	0	0	0	0	4	0	0	2	0	89	98	121	0	0
14:00	5796	45	0	0	0	0	0	2	0	0	1	0	90	97	104	0	0
15:00	6354	7	0	0	0	0	0	5	0	0	2	0	101	106	119	0	0
16:00	6066	8	0	0	0	0	0	1	0	0	1	0	95	101	111	0	0
17:00	5986	17	0	0	0	0	0	1	0	0	1	0	91	100	109	0	0
18:00	5630	7	0	0	0	0	0	2	0	0	0	0	89	94	100	0	0
19:00	5125	16	0	0	0	0	0	6	0	0	16	0	64	87	101	1	0
20:00	4396	12	0	0	0	0	0	4	0	0	30	0	64	75	99	0	0
21:00	4299	8	0	0	0	0	0	10	0	0	16	0	65	73	97	0	0
22:00	4893	6	0	0	0	0	0	6	0	0	12	0	63	83	105	0	0
23:00	3984	0	0	0	0	0	0	5	0	0	35	0	62	67	78	0	2
00:00	4647	3	0	0	0	0	0	6	0	0	23	0	63	79	101	0	0
01:00	3998	1	0	0	0	0	0	6	0	0	25	0	61	68	84	0	0
02:00	4177	0	0	0	0	0	0	6	0	0	27	0	60	72	99	0	1
03:00	4981	6	0	0	0	0	0	5	0	0	27	0	61	86	101	0	0
04:00	5300	6	0	0	0	0	0	4	0	0	1	0	79	89	98	0	1
04:45	4303	29	0	0	0	0	0	2	0	0	0	0	85	94	120	0	1
xx:xx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
xx:xx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
xx:xx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
xx:xx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	104636	305	0	0	0	0	0	83	0	0	252	0	60	89	121	1	5

Version 2.5.1123.2

CardioDay® V2.3

Version 2.5.1 | 2.3.2

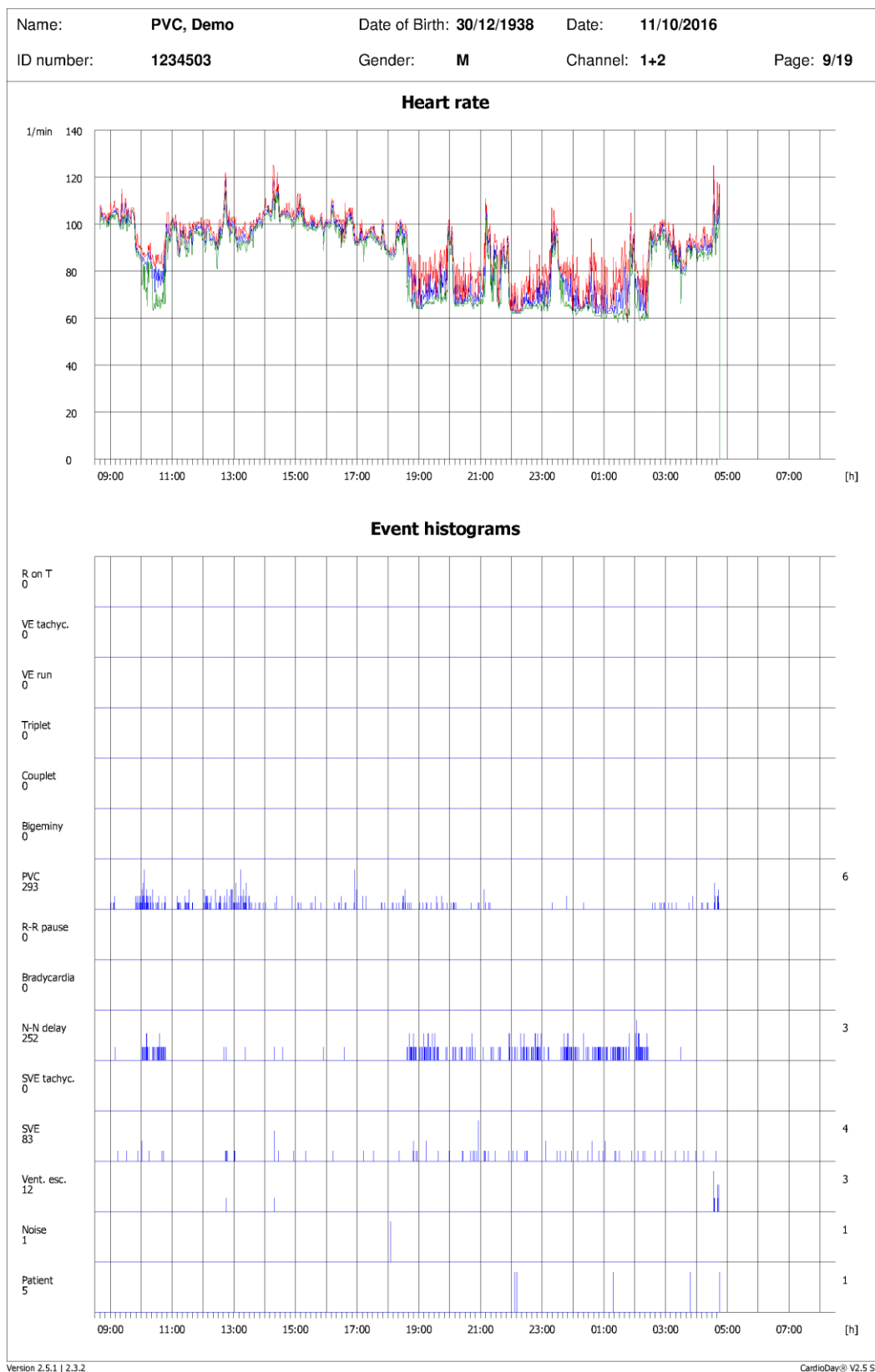
CardioDay® V2.5 SP1

Sample printout of a table of events occurring within one hour

Statistics > General > Event histogram

Select **Statistics > General > Event histogram** to print a graphical summary of the heart rate and a histogram of all events.

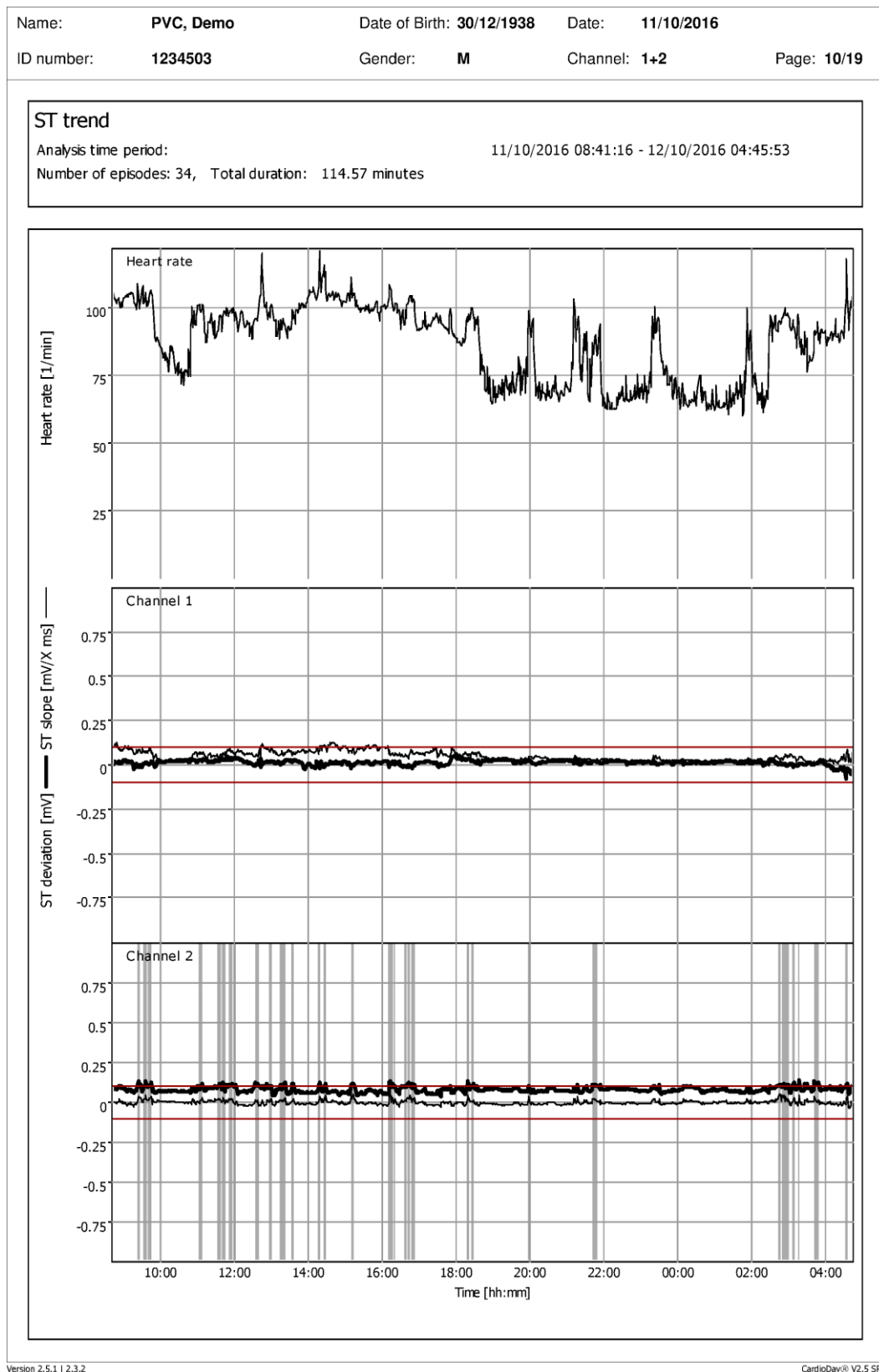
The event histograms are displayed as events per minute over the day of the recording. These histograms can be easily compared with the heart rate as they are displayed on the same printout.



Sample printout of the heart rate and event histograms

Statistics > General > ST trend

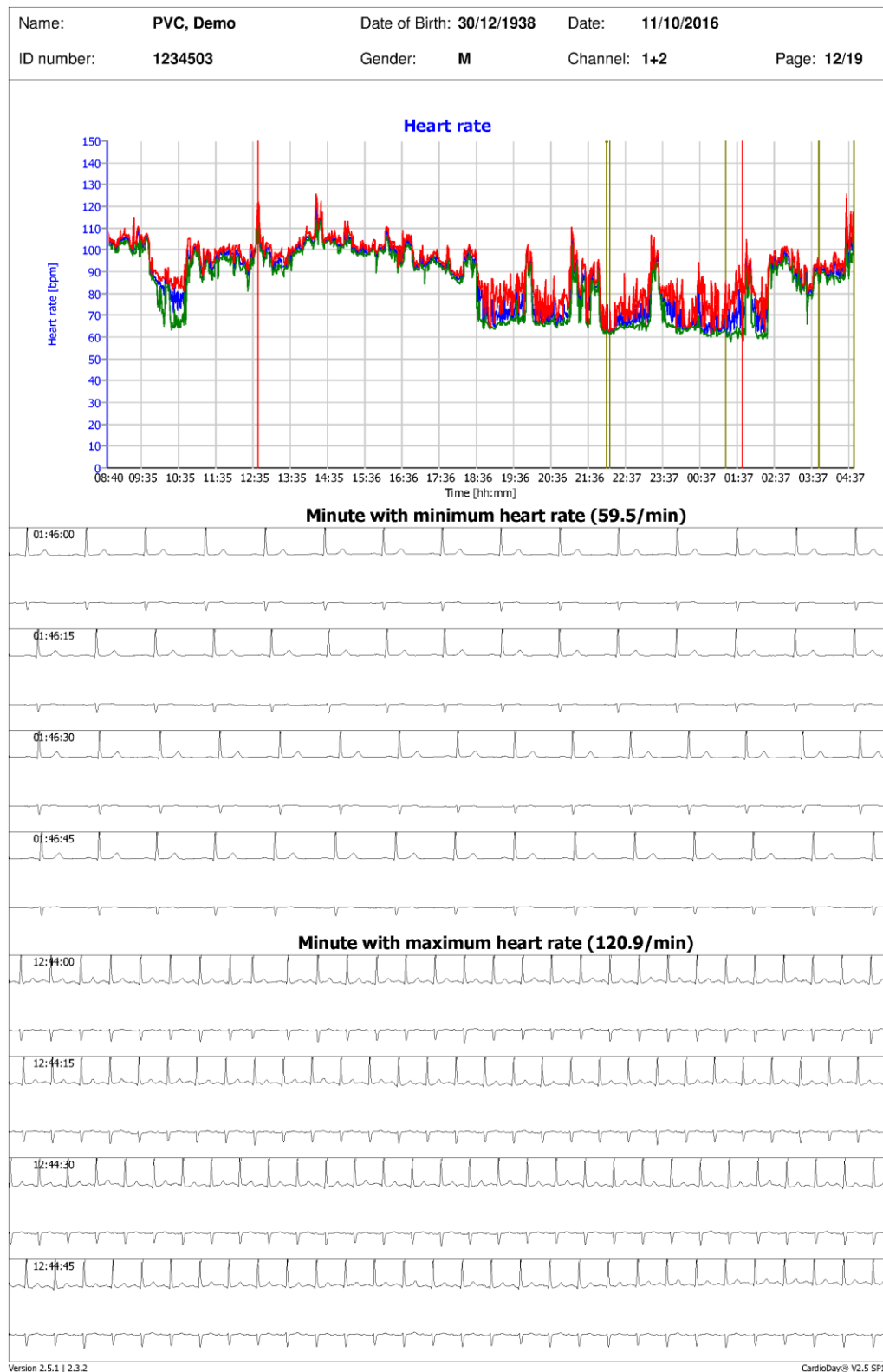
Select **Statistics > General > ST trend** to print ST deviation and ST slope for the measuring period.



Sample printout of heart rate and ST diagram

Statistics > General > HR diagram + Min/Max minute

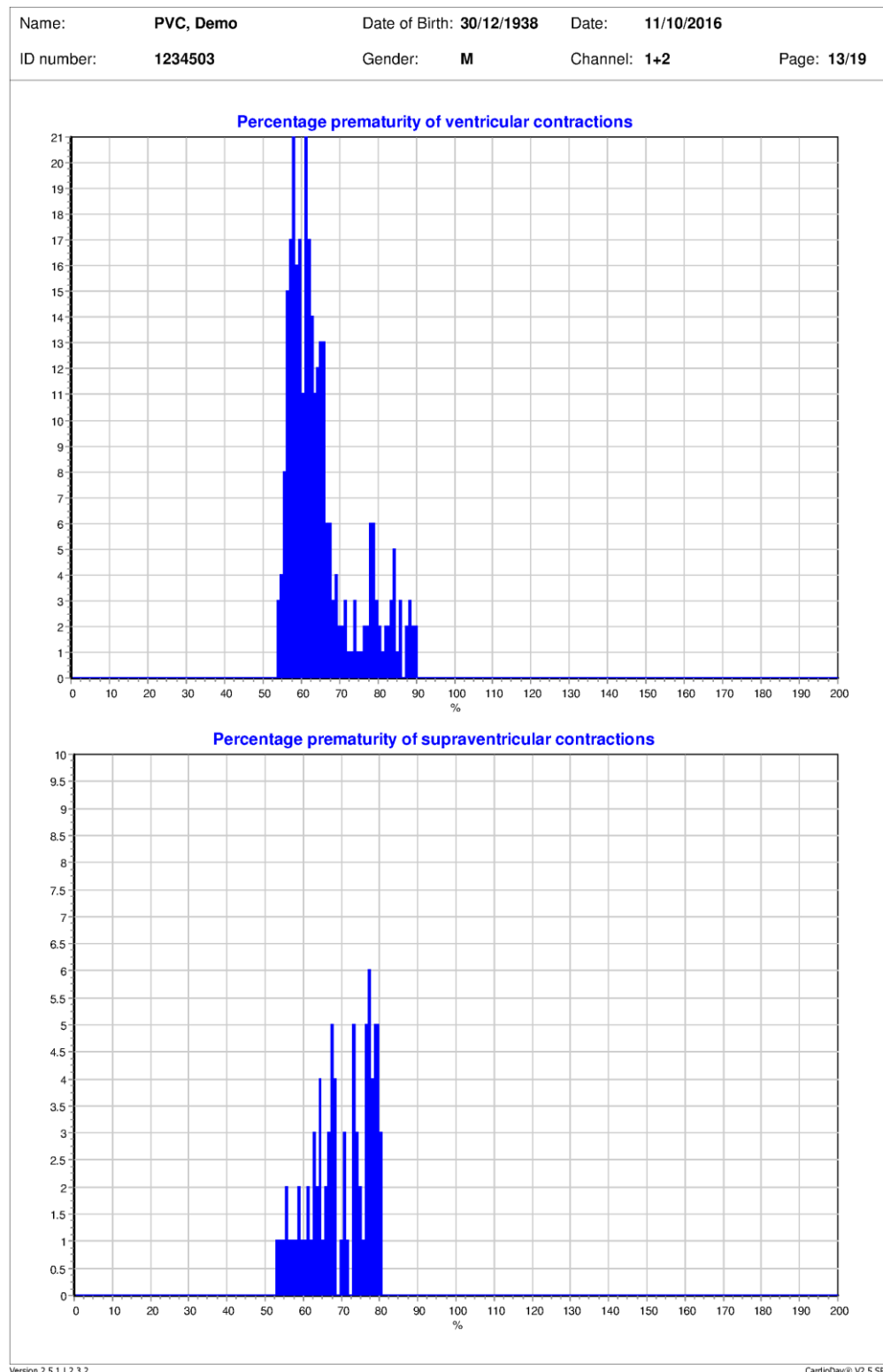
Select **Statistics > General > HR diagram + Min/Max minute** to print another graphical summary of the heart rate as well as ECG for the minutes with the highest and lowest heart rates:



Sample printout of the heart rate and ECG for the minutes with the highest and lowest heart rate

Statistics > General > PVC + SVE histograms

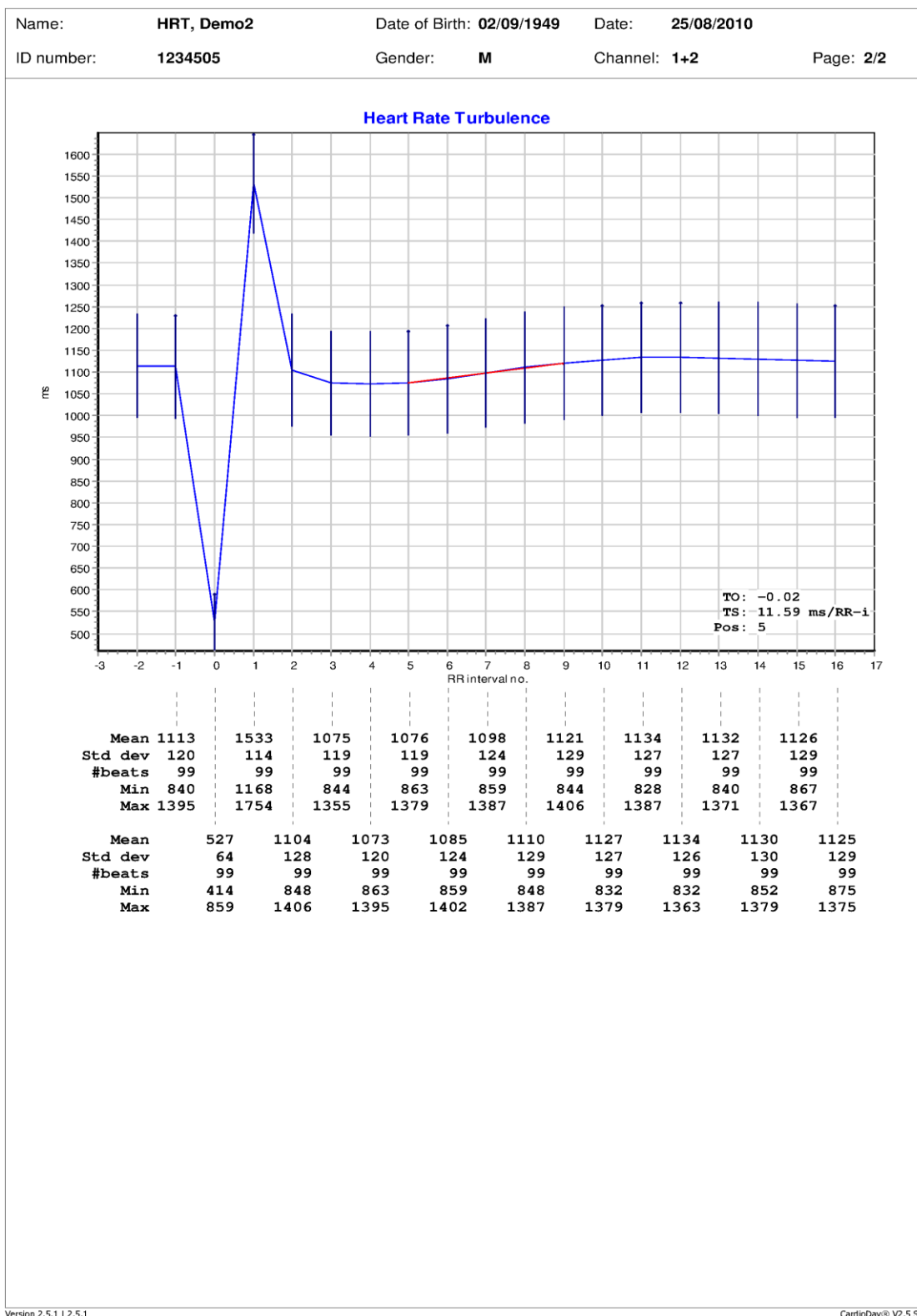
Select **Statistics > General > PVC + SVE histograms** to print two histograms of the percentage share of premature ventricular and supraventricular extrasystoles:



Sample printout of the histograms showing the percentage share of premature ventricular and supraventricular extrasystoles

Statistics > General > Heart Rate Turbulence

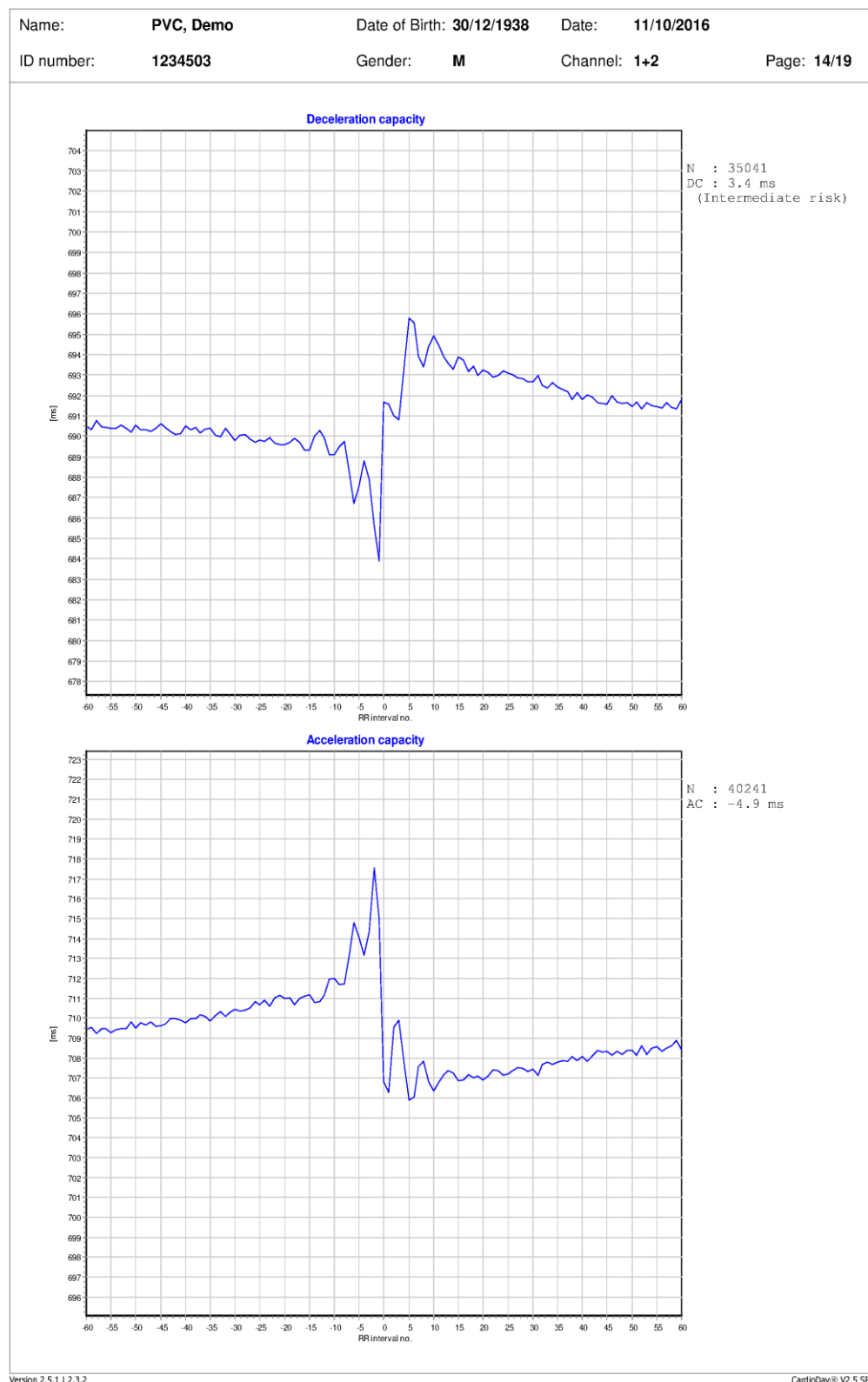
Select **Statistics > General > Heart Rate Turbulence** to print the diagram of the sum of the Heart Rate Turbulence together with the numerical values of the RR intervals.



Statistics > General > Heart Rate Turbulence

Statistics > General > AC/DC Capacity

Select **Statistics > General > AC/DC Capacity** to print the graphs for the Deceleration and Acceleration capacity.

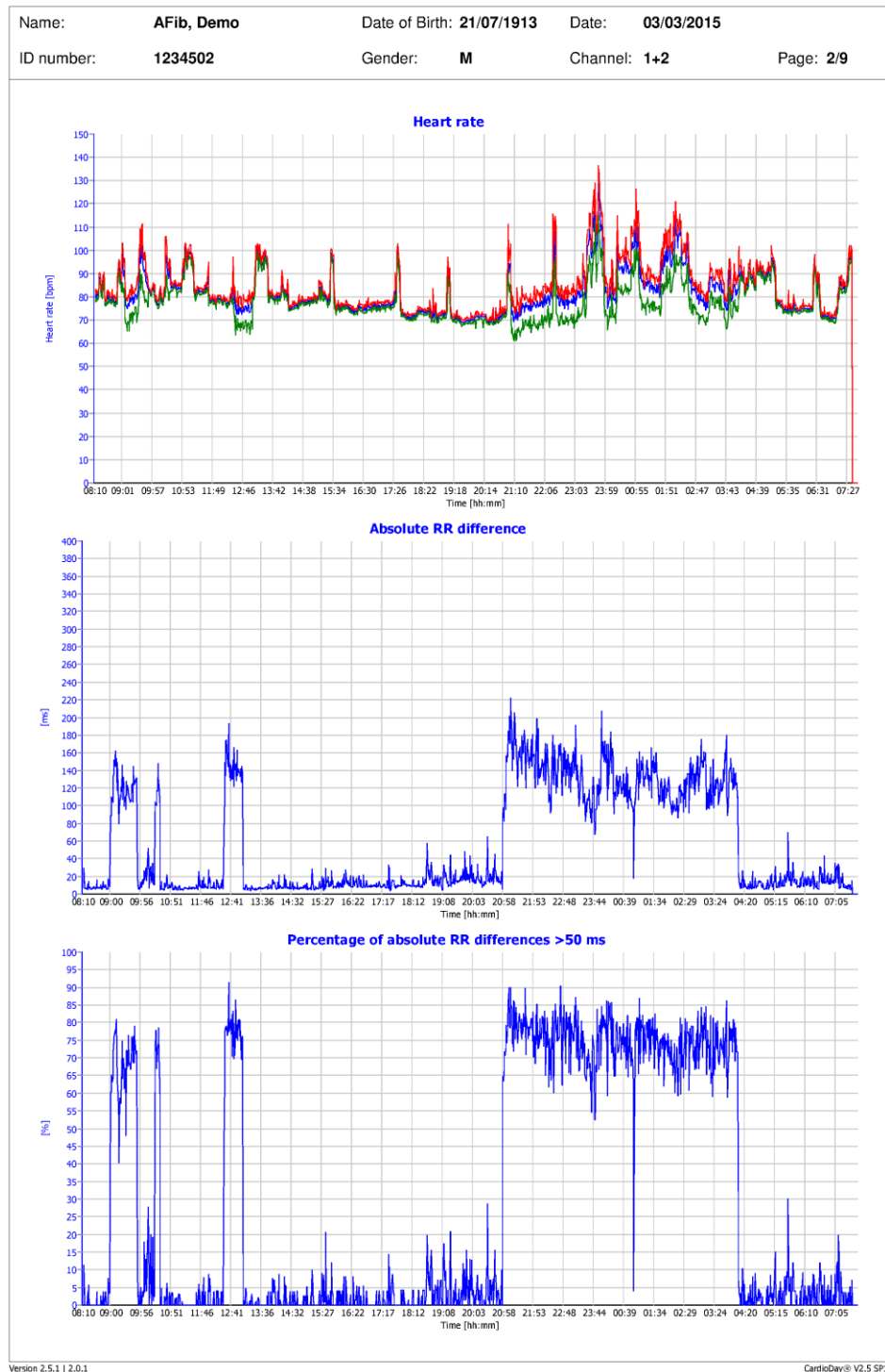


Statistics > General > AC / DC Capacity

Statistics > Heart rate variability (Standard) > YT/PNN50

Select **Statistics > Heart rate variability (Standard) > YT/PNN50** to print the average heart rate overview, the average value of the absolute RR differences, and the percentage share of the QRS complexes with an absolute RR difference greater than 50 ms.

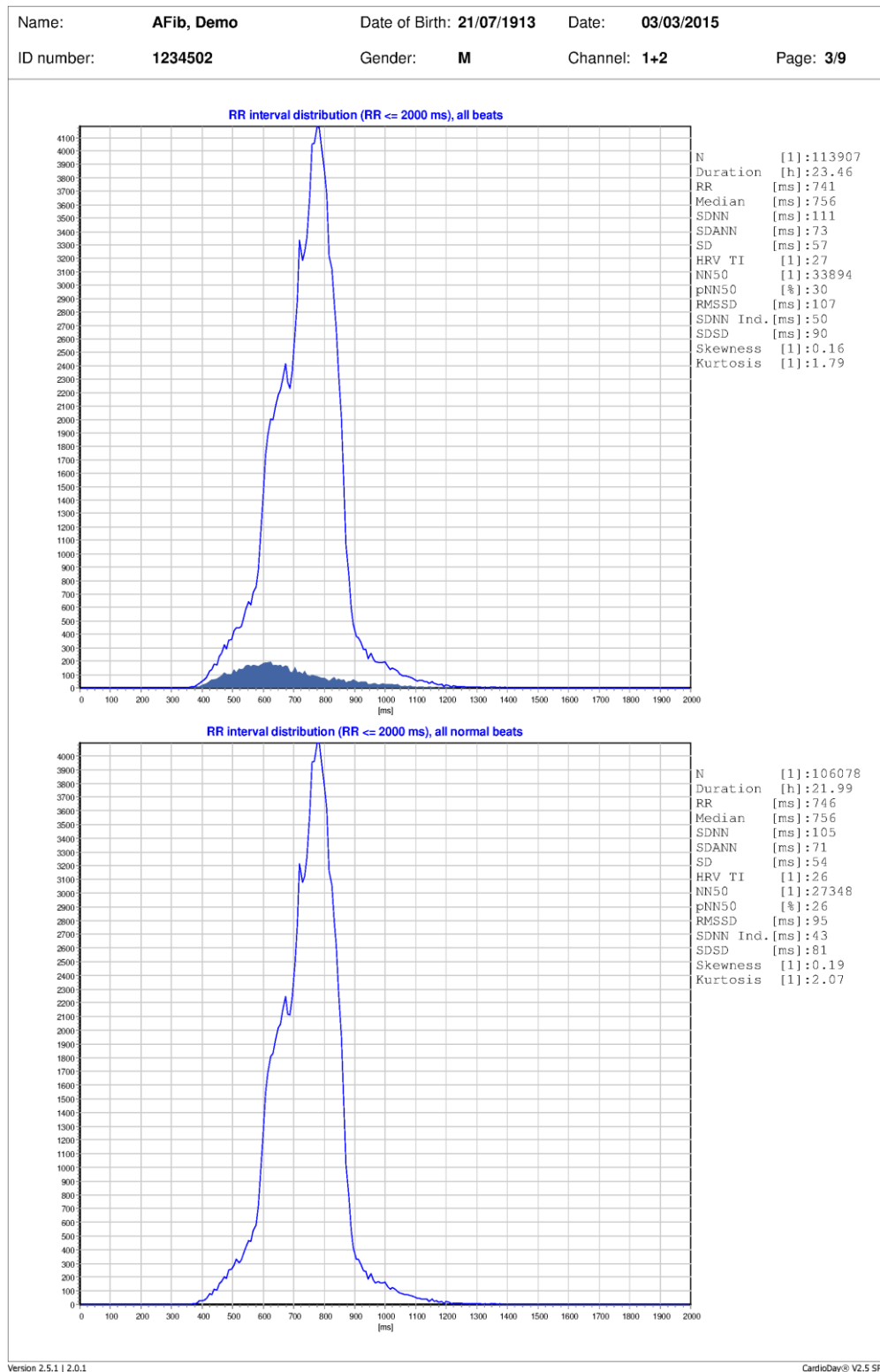
All figures display average values calculated over one minute.



Sample printout of the absolute RR differences and the share of absolute RR differences larger than 50 milliseconds, minute values

Statistics > Advanced heart rate variability (RR-FFT) > RR intervals

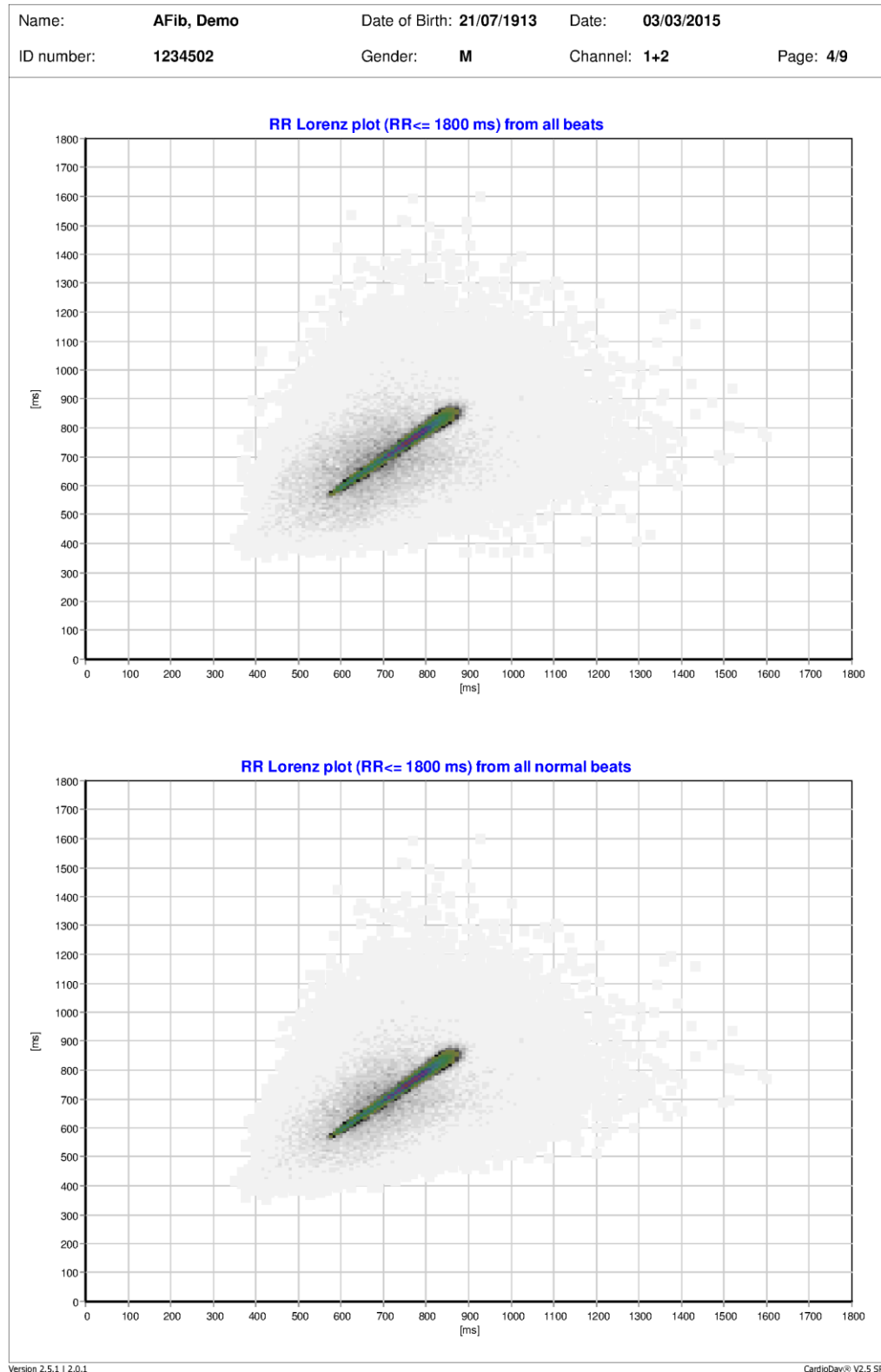
Select **Statistics > Advanced heart rate variability (RR-FFT) > RR intervals** to print the **RR interval distribution** and a number of statistical parameters of all beats and of all normal beats over the measuring period:



Sample printout of the RR interval distribution

Statistics > Advanced heart rate variability (RR-FFT) > RR Lorenz plot

Select **Statistics > Advanced heart rate variability (RR-FFT) > RR Lorenz plot** to print the Lorenz plot of all RR intervals during the measuring period:

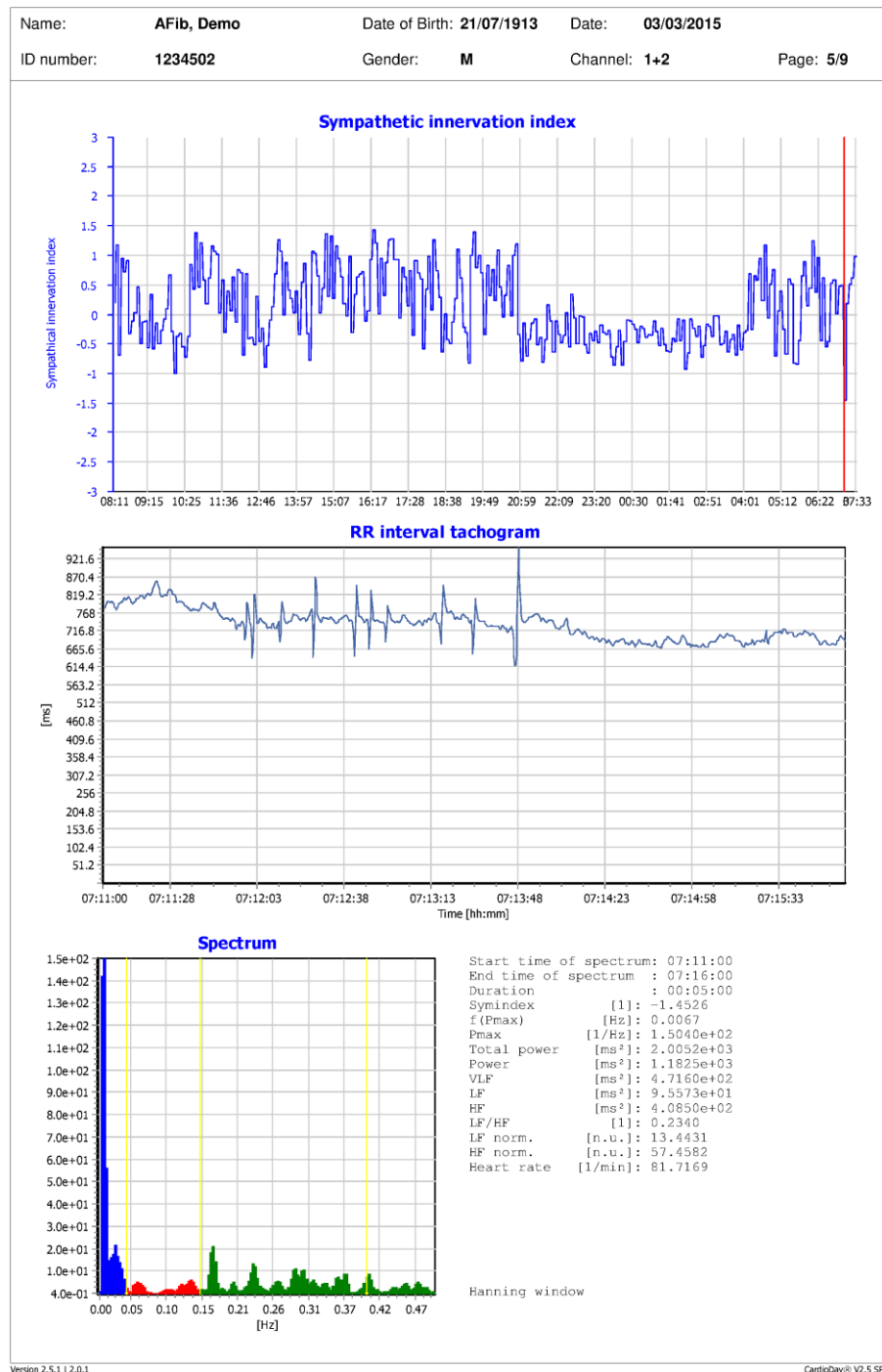


Sample printout of the RR Lorenz plot

Rhythm problems (here, for example, atrial fibrillation) cause a deviation from the ideal shape of a baseball hat with a slope of 45 degrees. This RR Lorenz plot is generated by determining a graphical coordinate from each RR interval and its predecessor. The frequency of occurrence of each coordinate is then displayed in color on the diagram. This display allows a quick evaluation of whether or not rhythm problems are present.

Statistics > Advanced heart rate variability (RR-FFT) > Min. sympathy. innervation index

The option **Statistics > Advanced heart rate variability (RR-FFT) > Min. sympath. innervation index** prints the RR tachogram and RR interval spectrum of those 5-minute periods of which the sympathetic innervation index has the maximum negative value. A basic description on calculating this parameter is given in the section "Heart rate variability > RR-FFT" on page 123.



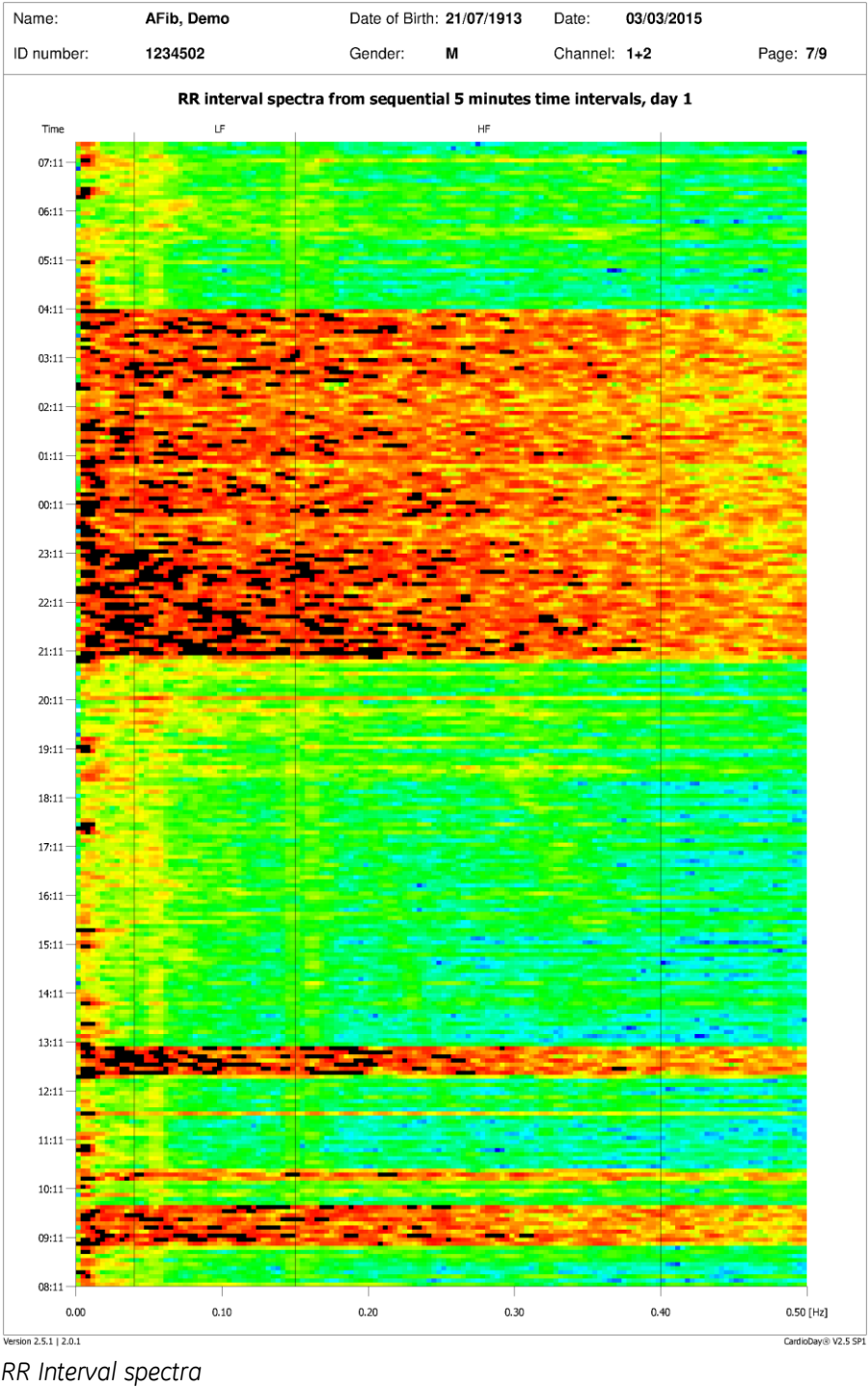
Minimal sympath. innervation index

Statistics > Advanced heart rate variability (RR-FFT) > 24 h RR-FFT

The printout shows the graphic represented in the section “Heart rate variability > RR-FFT” on page 123.

Statistics > Advanced heart rate variability (RR-FFT) > RR interval spectra

The *RR interval spectra* provide an overview of the results of the spectro-temporal RR interval analysis in subsequent 5-minute time segments.



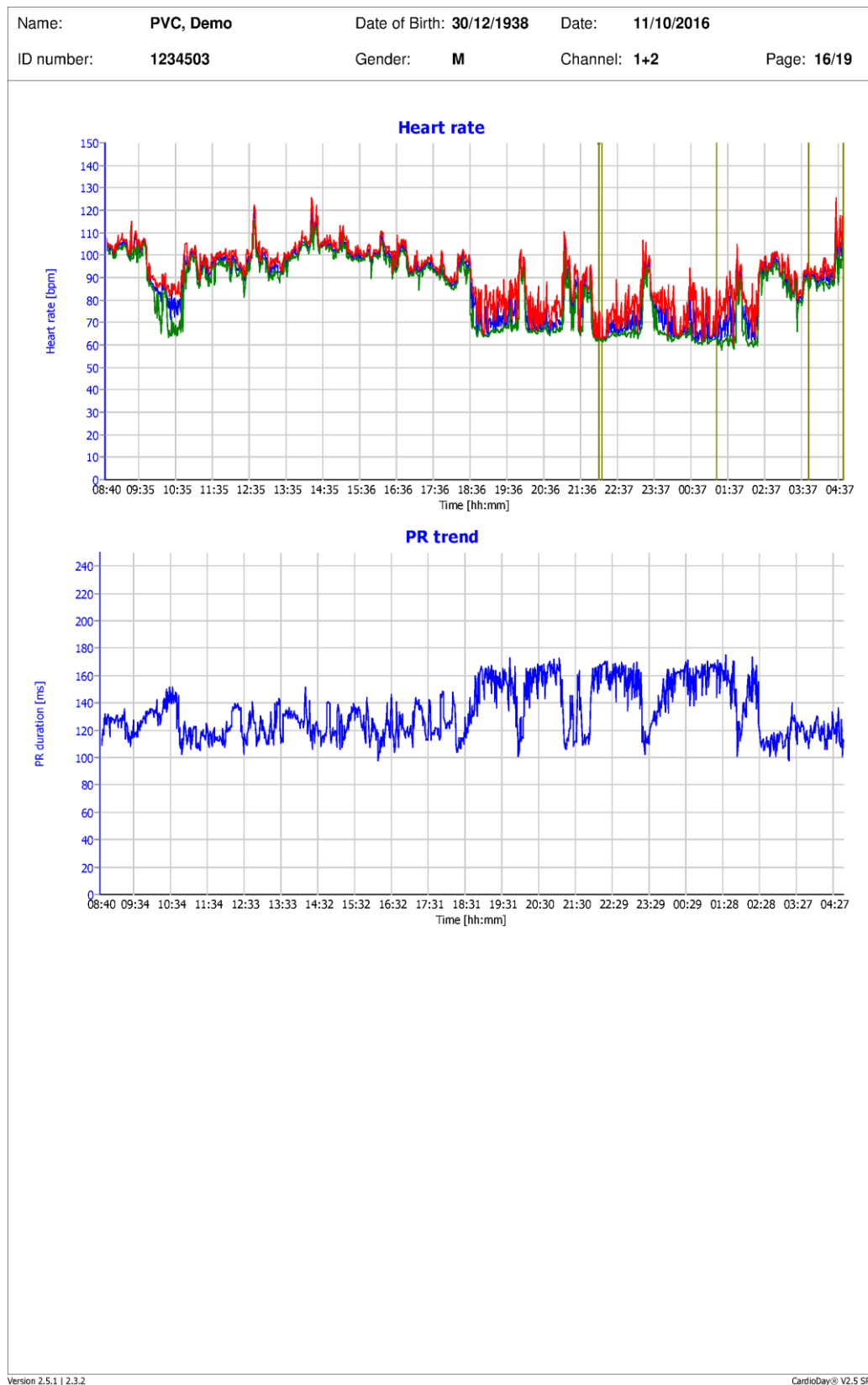
The spectral power for each spectrum is auto-scaled to its maximum value and color-coded according to the color bars used with the RR delay. The recording start is located at the bottom of the graph. Each spectrum is displayed according to its starting time, which is shown on the y-axis. The abscissa shows the frequency range between 0 Hz and 0.5 Hz.

Orange-red colors indicate a higher spectral density than green and blue colors.

During periods of physical activity and wakefulness, the higher power density is found at 0.1 Hz or lower frequencies. During periods of undisturbed respiratory sinus arrhythmia, the higher spectral power density is found in the HF frequency band.

Statistics > PR/QT trend > PR trend

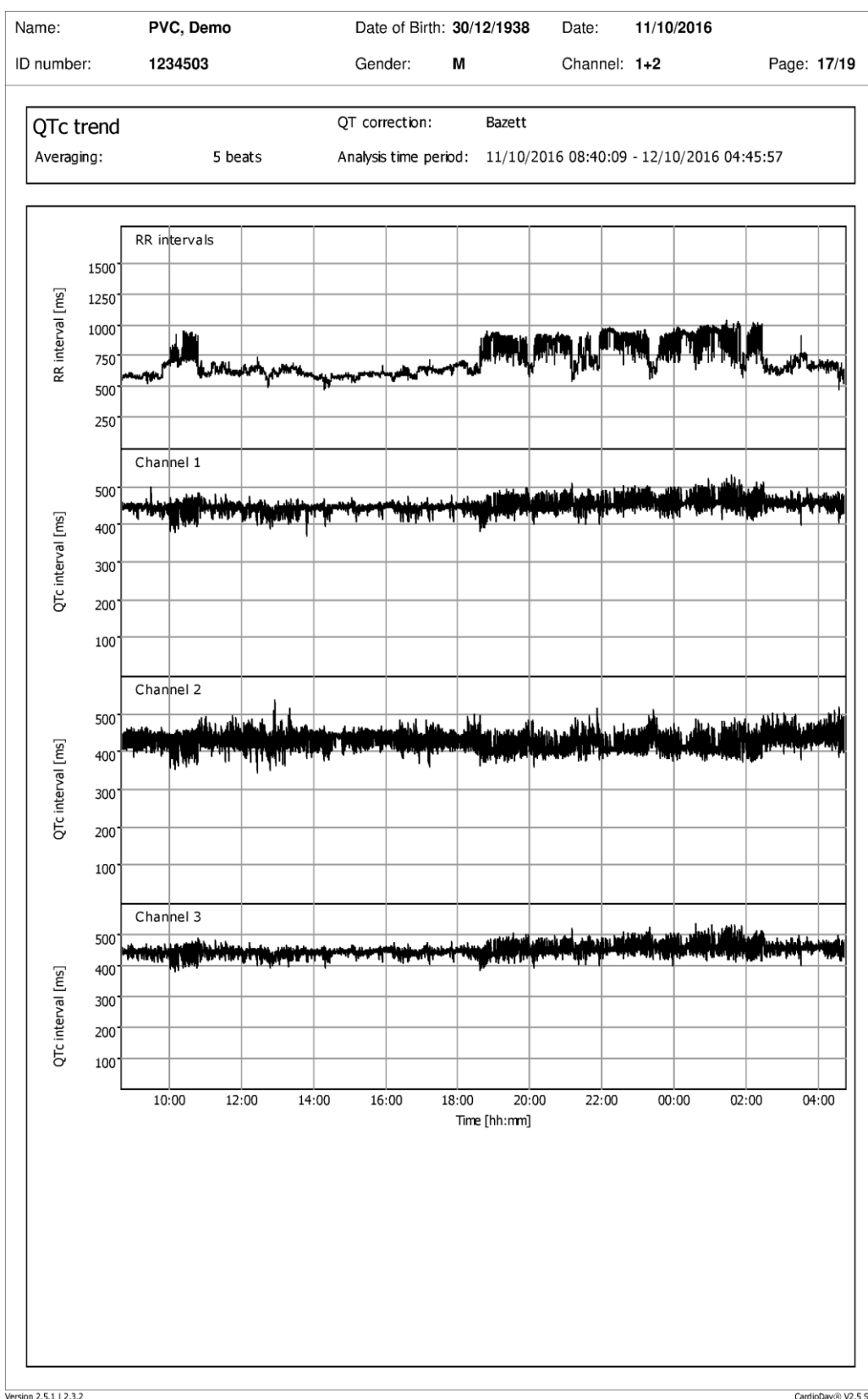
This option prints an overview of the **PR Trend** in addition to an overview of the average heart rate.



Sample printout of the PR duration

Statistics > PR/QT trend > QT-/QTc trend

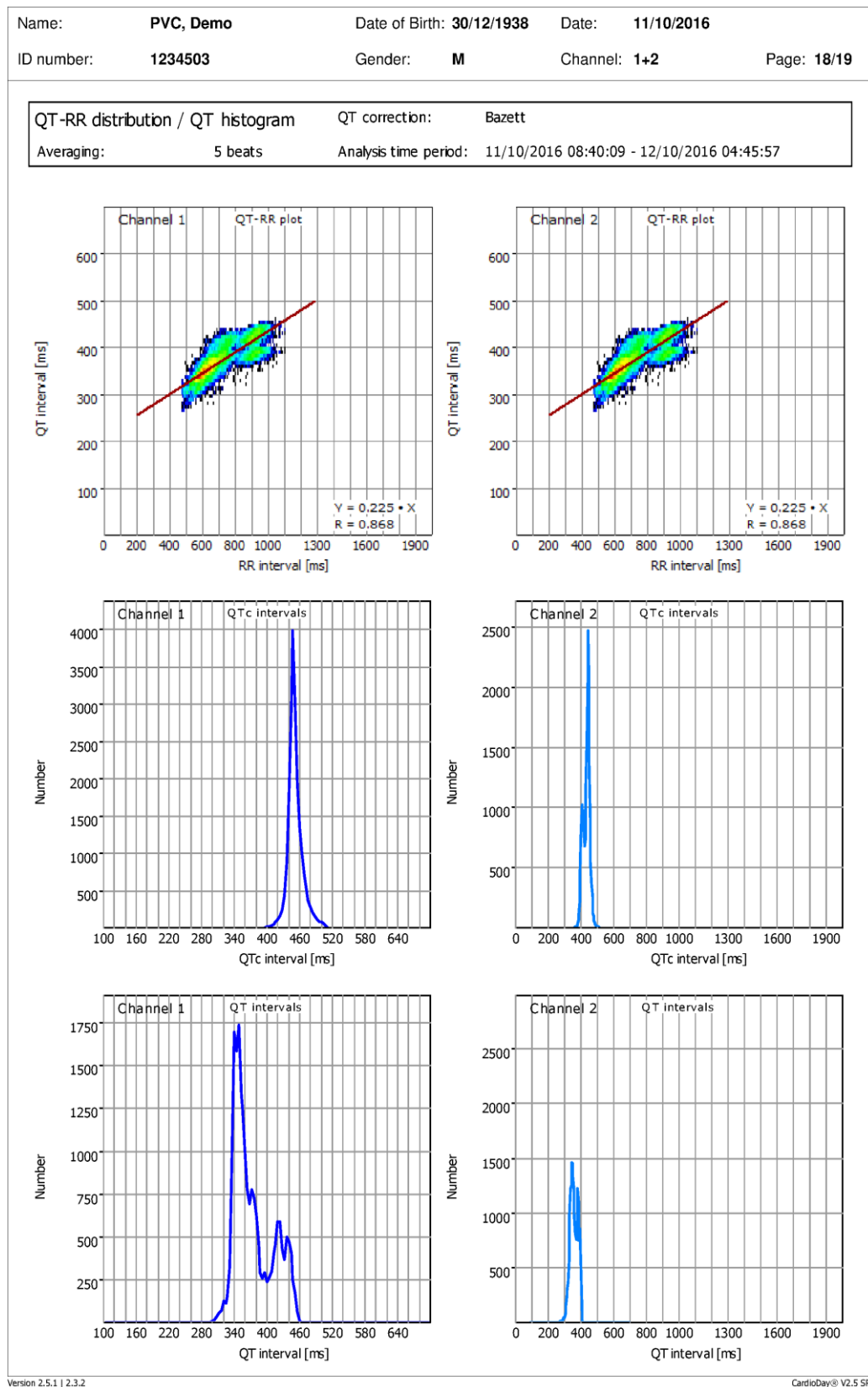
This option prints overviews of the QT and QTc intervals in addition to an overview of the average heart rate.



Sample printout of the QT trend

Statistics > PR/QT trend > QT histogram

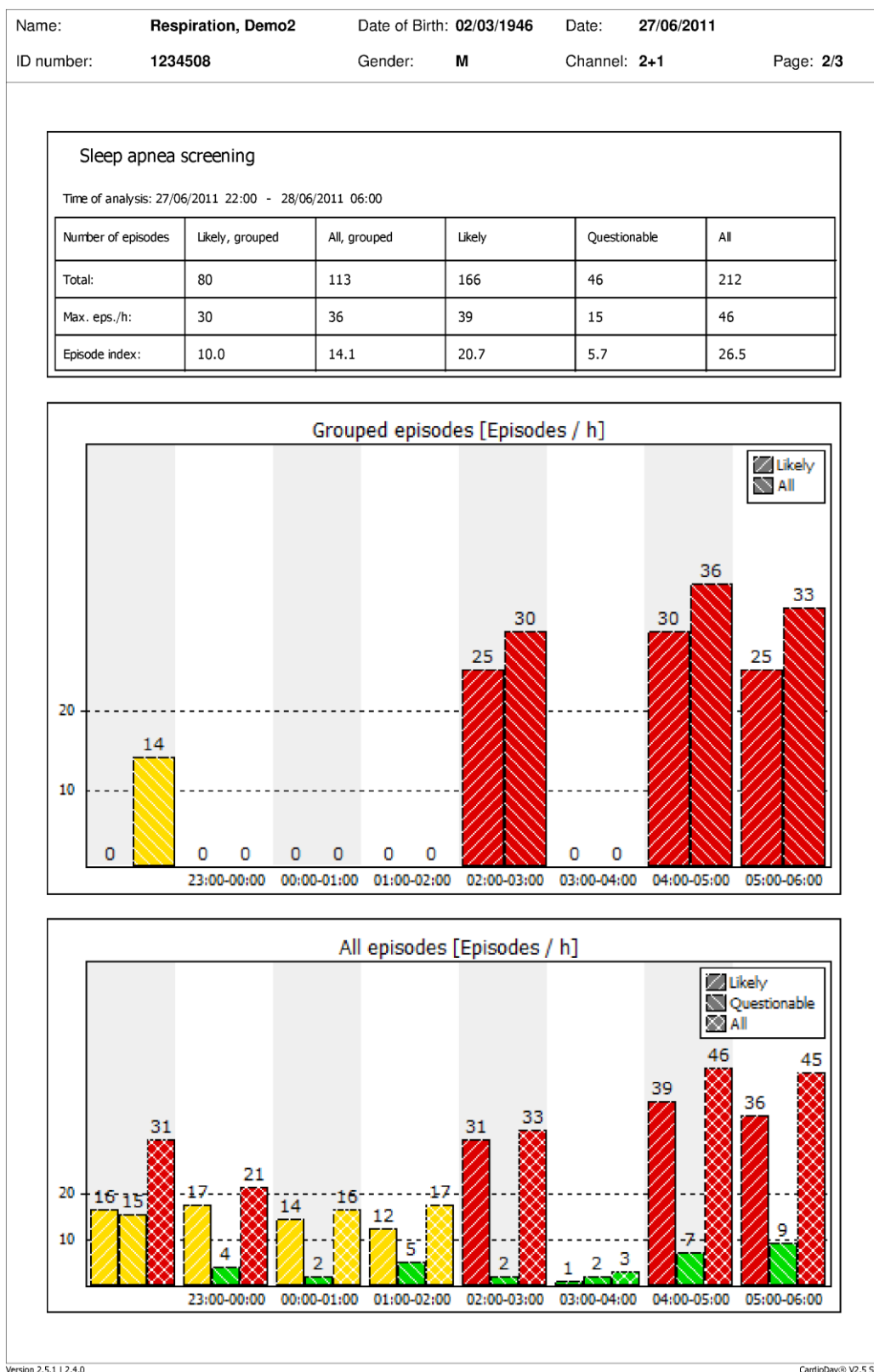
This option prints the QT-RR distribution for the QT histogram as well as for the QT and QTc intervals.



Sample printout of the QT histogram

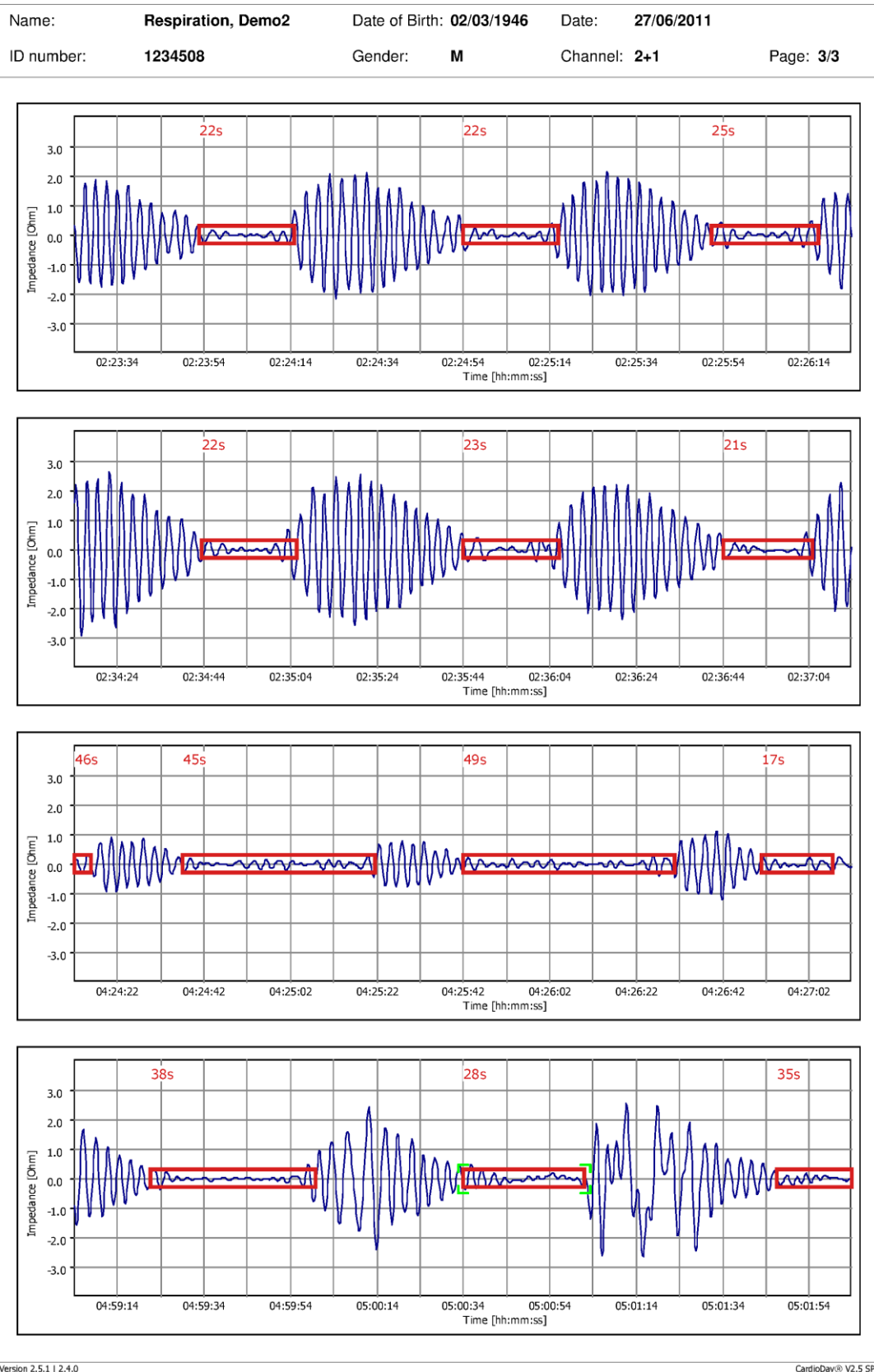
Print > Respiration > Overview and Marked episodes

The **Overview** option prints the report table and overview graphics of the respiration episodes.



Sample Printout Respiration > Overview

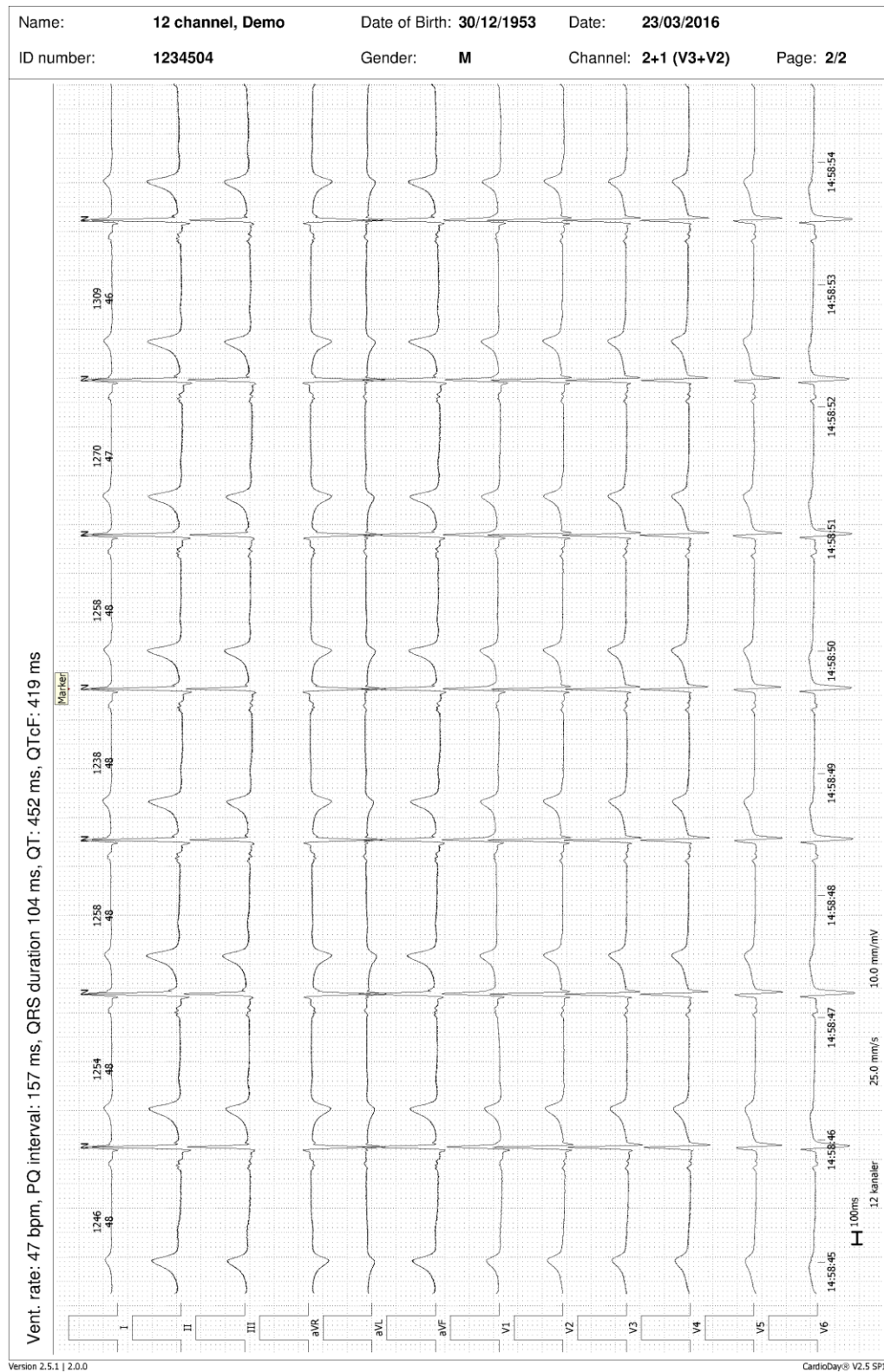
The **Marked episodes** option prints all detected likely and questionable events that were detected during the respiration analysis period.



Sample printout Respiration > Marked episodes

Print > 12-channel ECG

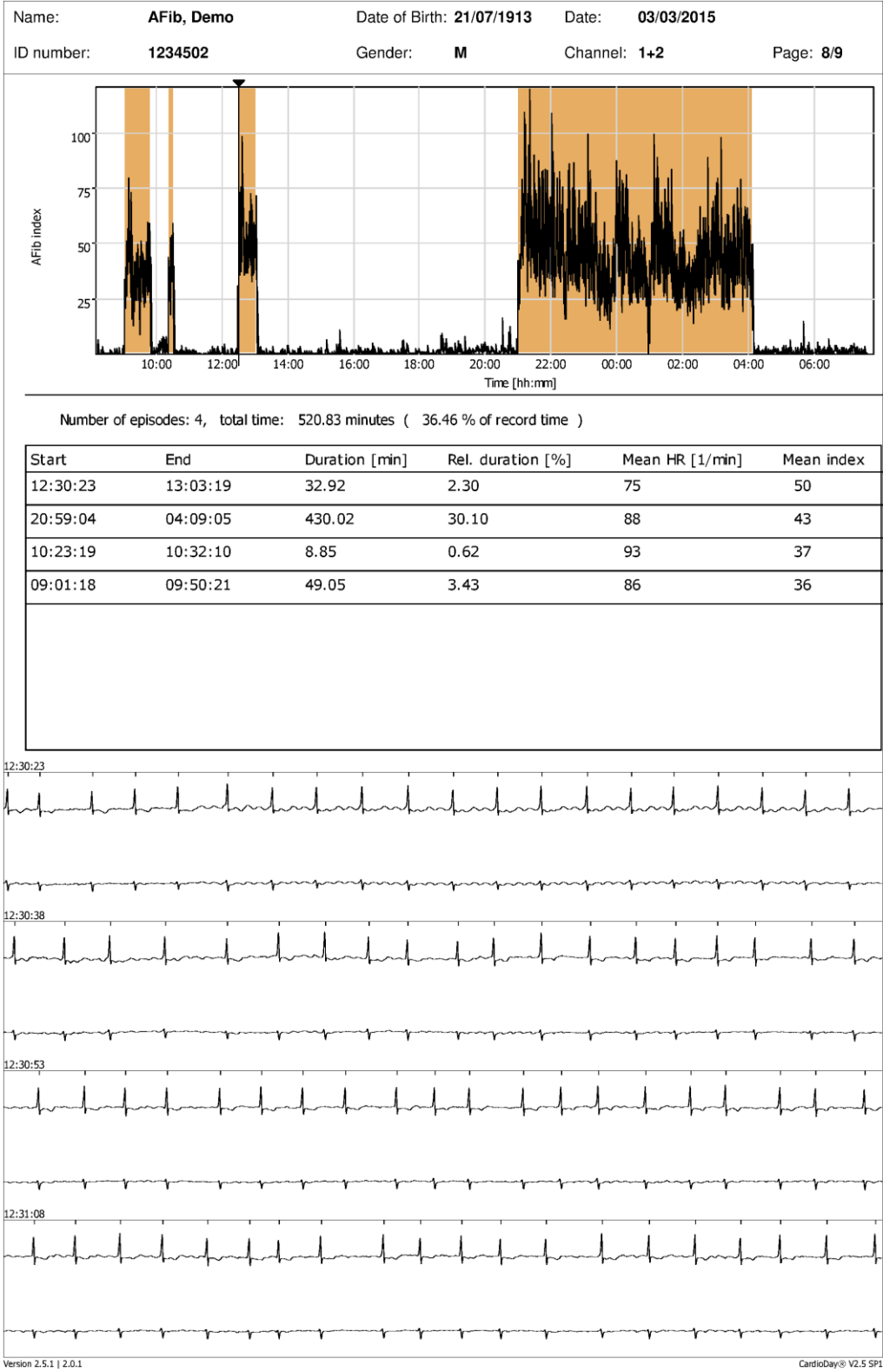
This option prints the selected 12-channel markers that are highlighted in the marker list on the **12-channel ECG** tab. Note that the marker type needs to be configured in the marker set up in order to be active for print.



Sample printout 12-channel ECG

Print > AFib > Statistic

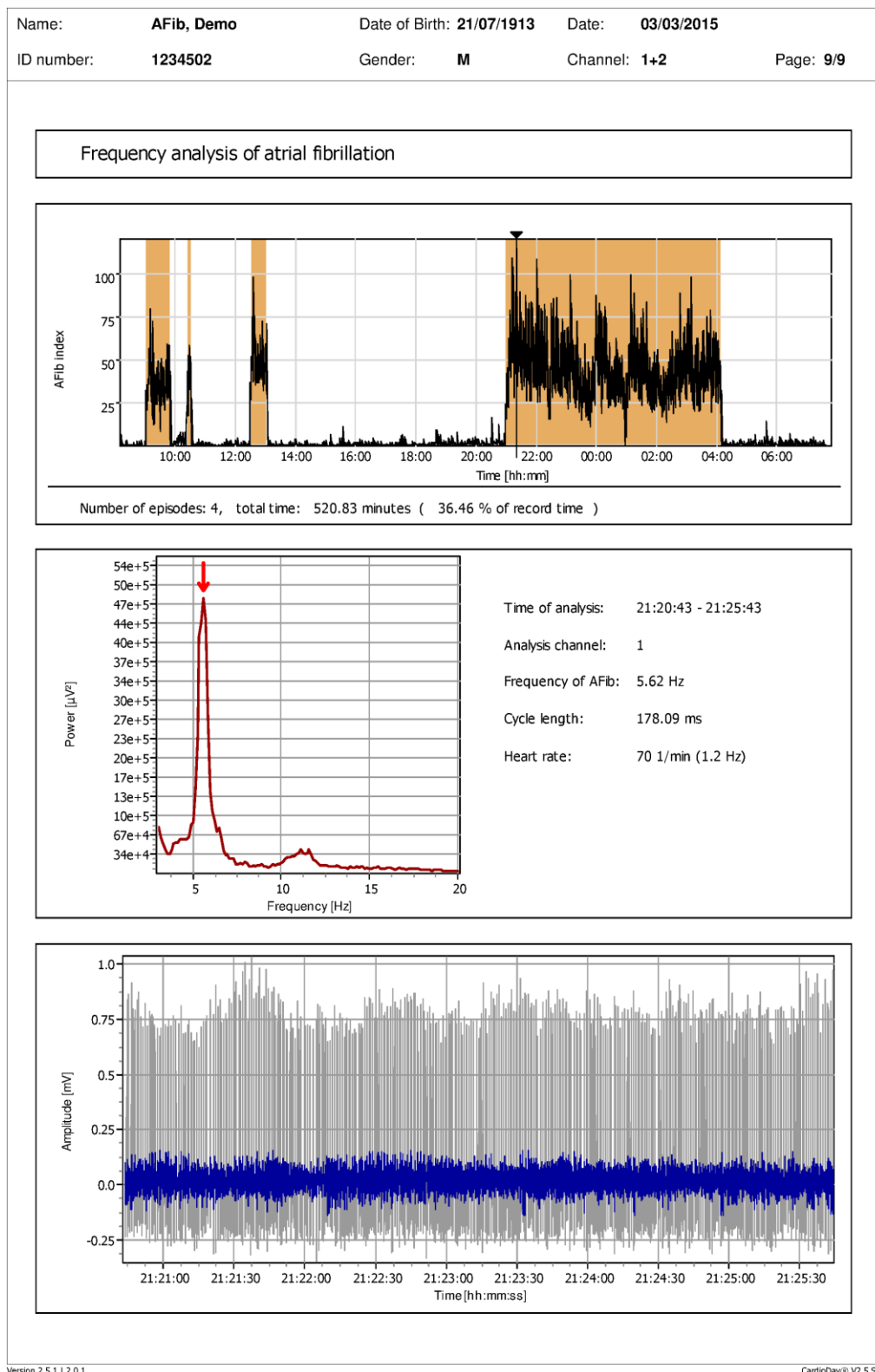
This option prints the calculated fibrillation index with indications of atrial fibrillation as colored regions. Furthermore, it displays a table with detailed information about the detected regions.



Sample printout AFib, Statistics

Print > AFib > Frequency analysis

This option prints the calculated fibrillation index with indications of atrial fibrillation as colored regions as well as the frequency spectrum of the maximum frequency of atrial fibrillation that has been detected.



Version 2.5.1 | 2.0.1

CardioDay® V2.5 SP1

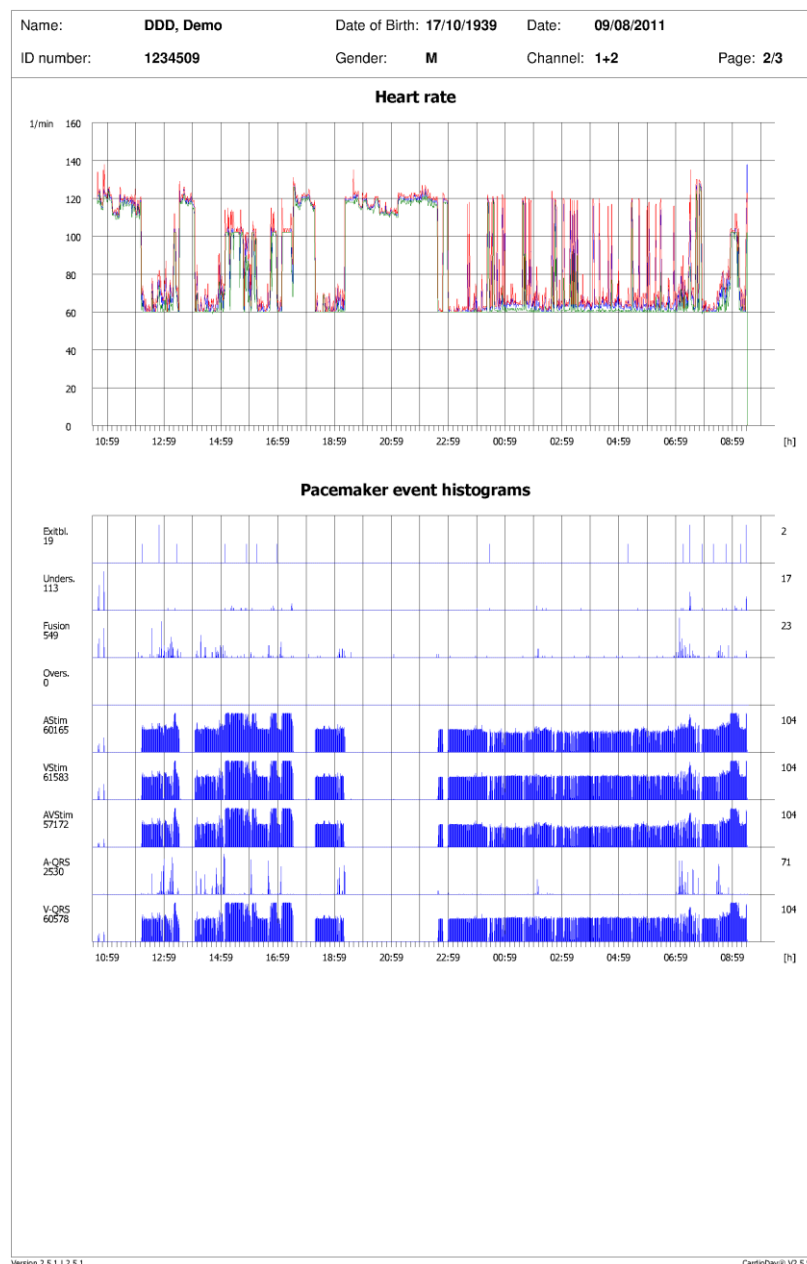
Sample printout AFib, Frequency analysis

Print > Pacemaker

The options listed under **Pacemaker** document the events found and the results of the pacemaker analysis. They print the results determined on the **PM events** tab.

Pacemaker > Event histogram

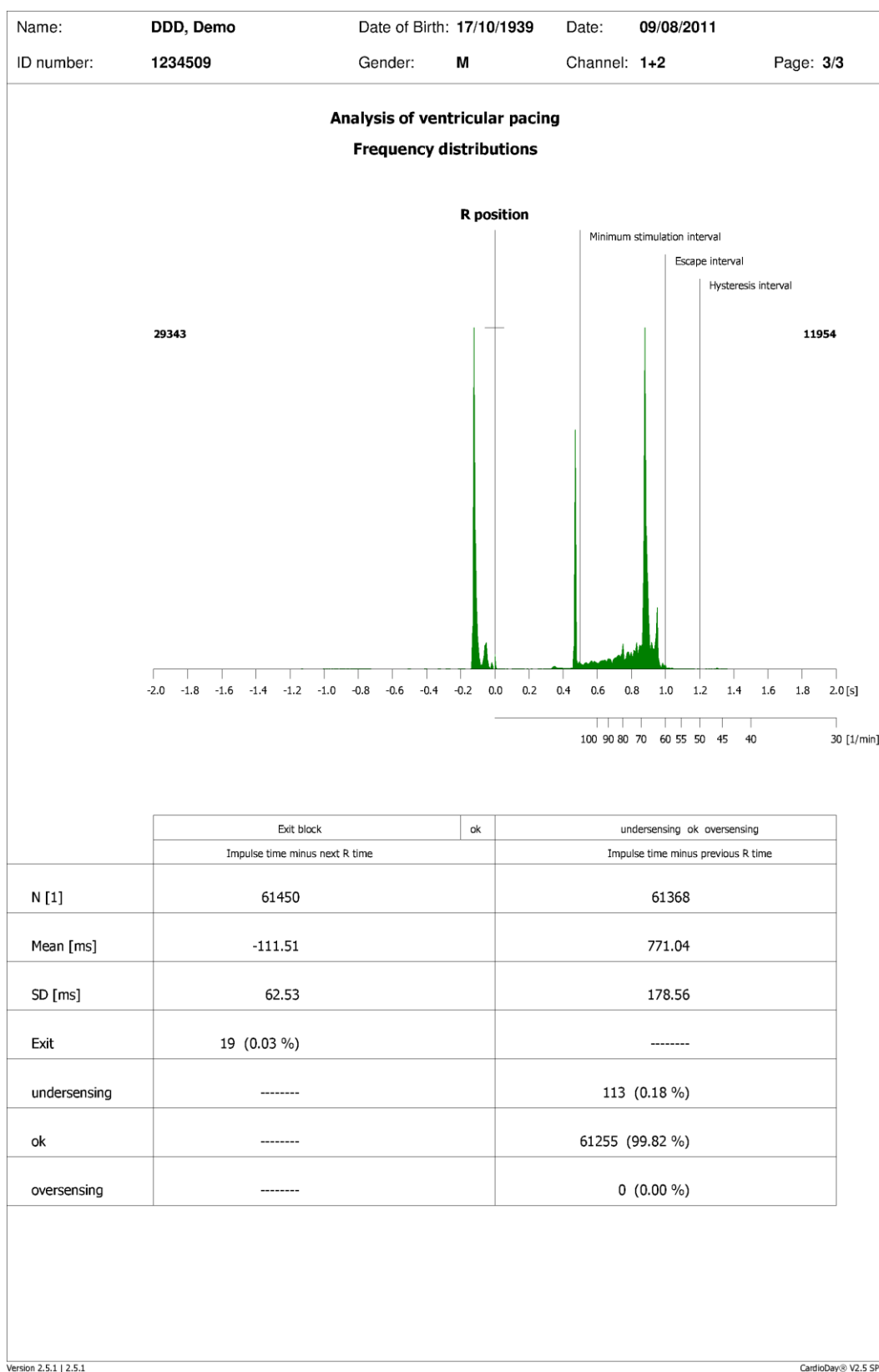
Select **Pacemaker > Event histogram** to print a summary of the heart rate and a histogram of all events related to pacemaker functioning. The printout is very similar to that of the **Statistics > Event histogram** option except that it includes the pacemaker events already described in the section “[The PM \(Pacemaker\) events tab](#)” on page 113.



Sample printout of a Pacemaker Event histogram

Pacemaker > Function analysis

The functional analysis of ventricular pacemaker stimulation displays two frequency distributions in the graph.



Sample printout of the Pacemaker Function analysis

Statistical calculation

The ordinate shows the absolute frequencies of all events that occurred during the entire recording period using a class width of 8 milliseconds.

The positive abscissa, that is, the right part of the graph, shows the time interval from the position of the R peak to the next ventricular pacemaker stimulation impulse detected by CardioDay.

In addition, the minimum stimulation interval of the pacemaker (for pacemakers with variable stimulation frequency, this value is calculated from the maximum stimulation frequency), the ventricular escape interval (calculated from the minimum stimulation frequency), and the hysteresis interval (calculated from the hysteresis frequency) are marked with dashed and vertical blue lines. These lines could all coincide, for example, in the case of a VVI pacemaker without a programmed hysteresis frequency.

Relevance

If the frequency distribution in the right part of the graph lies before or during the escape interval in the range of the set stimulation frequency of the pacemaker, then no ventricular oversensing has occurred.

If a significant amount of stimulation impulses occurs within a short period after the preceding R peak, significant ventricular undersensing has occurred. In this case, the pacemaker gives a significant number of stimulation impulses even though an R peak occurred shortly beforehand, which was detected by the Holter ECG but not by the pacemaker. This can happen, for example, if the pacemaker ventricular sensing threshold is too high or the contact resistance between the ventricle electrode and the myocardium is too large.

Events that could be mistaken for ventricular undersensing may also be caused by false triggering of the evaluation algorithm of CardioDay. Also to be considered is possible breakage of the ventricular pacemaker electrode, which can sometimes cause an interruption of the electrode's electrical conduction only during certain movements of the patient.

In pacemakers with variable stimulation frequency, the peak of the frequency distribution will lie at the most frequently occurring stimulation frequency. It is therefore normal for this peak to lie to the left of the escape interval (e.g., DDD-R or VVI-R pacemaker mode). This should not be confused with ventricular undersensing.

If stimulation impulses appear to the right of the escape interval by any appreciable amount, significant ventricular oversensing has occurred. The interval between the preceding R peak and the next ventricular pacemaker stimulation impulse is then often longer than it should be based on the escape interval of the pacemaker. In this case, the pacemaker is inhibited even though the escape interval

has already passed. This is usually caused by extracardial myopotentials when the pacemaker has a low ventricular sensing threshold, or—also intermittently—when electrode breakage, electrode dislocation, or pacemaker dysfunction due to other causes is observed.

If the pacemaker has a programmed hysteresis frequency, the previous considerations should be made using the hysteresis interval and not the escape interval.

The frequency distribution is shown in green. However, all values that lie outside the interval specified by the mean $\pm$ two standard deviations are displayed in red.

The positive abscissa also includes an additional abscissa computed in the units of “beats per minute” to allow a better comparison of the frequency distribution results with the programmed frequency values of the pacemaker.

The negative abscissa, that is, the left side of the graph, shows the time interval between the ventricular stimulation impulse and the next R peak detected in the Holter ECG. This interval should normally be less than 150 ms. If it is longer, the frequency distribution will be shifted to the left, because the abscissa is negative. This means that not every ventricular stimulation impulse led to an R peak, i.e., a significant amount of exit blocks occurs. This could be caused, for example, by electrode dislocation, electrode breakage, or too much contact resistance between the ventricle electrode and the myocardium. It could also occur if the ventricular stimulation amplitude is too small, the ventricular stimulation duration is too short, or the batteries are too weak. In patients whose own ventricular rhythm is inadequate, the ventricular exit block poses a threatening situation.

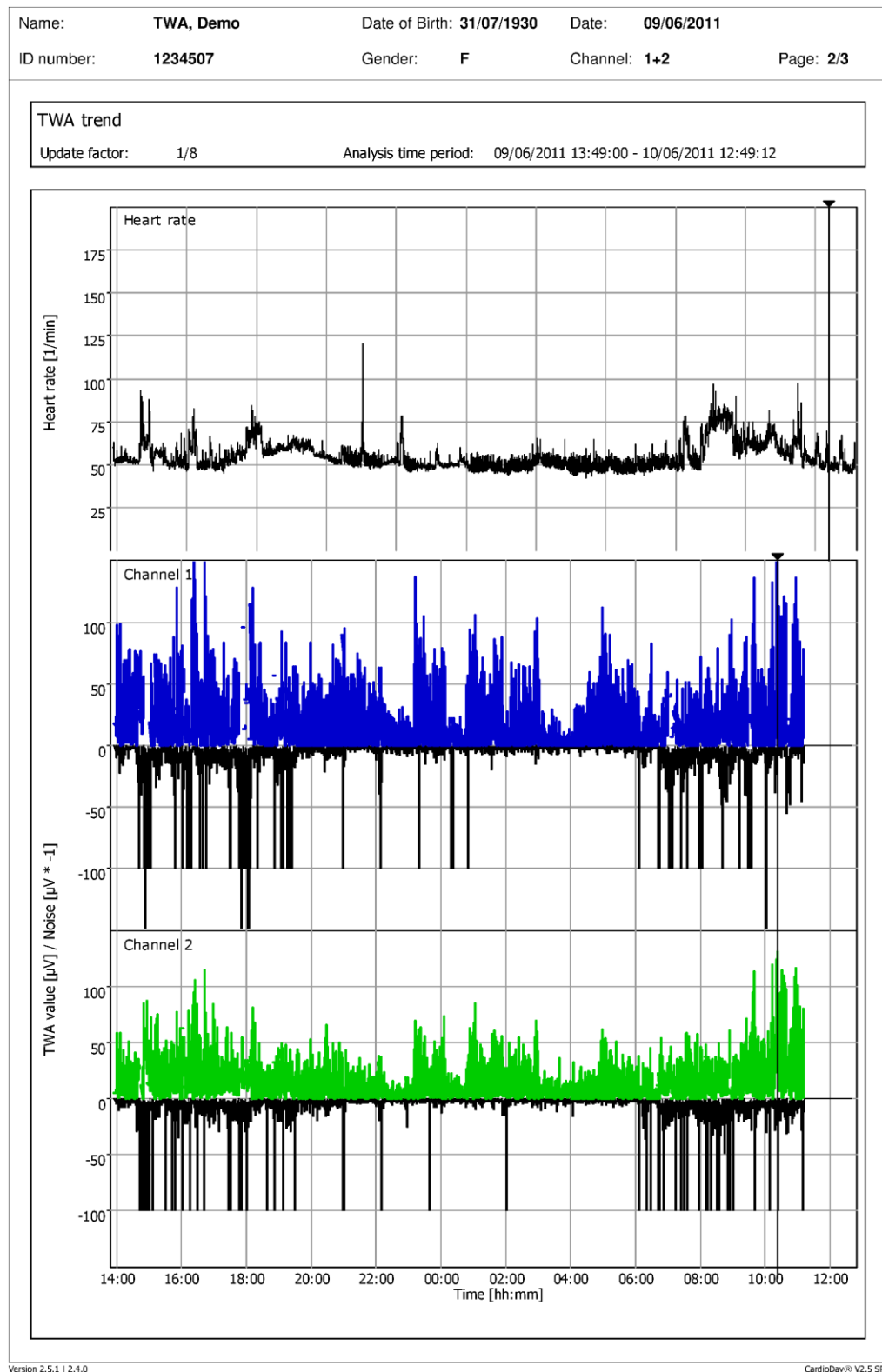
The frequency distribution is marked in green. All values that correspond to more than a 200 ms interval between the ventricular pacemaker impulse and the next R wave, i.e., where ventricular exit blocks are possible, are marked in red. In this case, ventricular exit blocks are possible.

In the lower half of the page, the statistical parameters mean and standard deviation for the aforementioned frequency distributions are shown. Further results refer to the absolute and relative frequencies of the exit blocks and the undersensing and oversensing events. These are not calculated from the frequency distributions; they are instead taken from the edited table of pacemaker events.

In summary, the graphical and statistical display of the ventricular stimulation is intended to provide a quick overview of the correct functioning of the pacemaker’s ventricular stimulation and to help in the detection of frequent ventricular exit blocks and ventricular undersensing and oversensing. The resulting characteristic shift of the frequency distributions is used to recognize malfunctions of the pacemaker at a glance.

Print > TWA > Trend

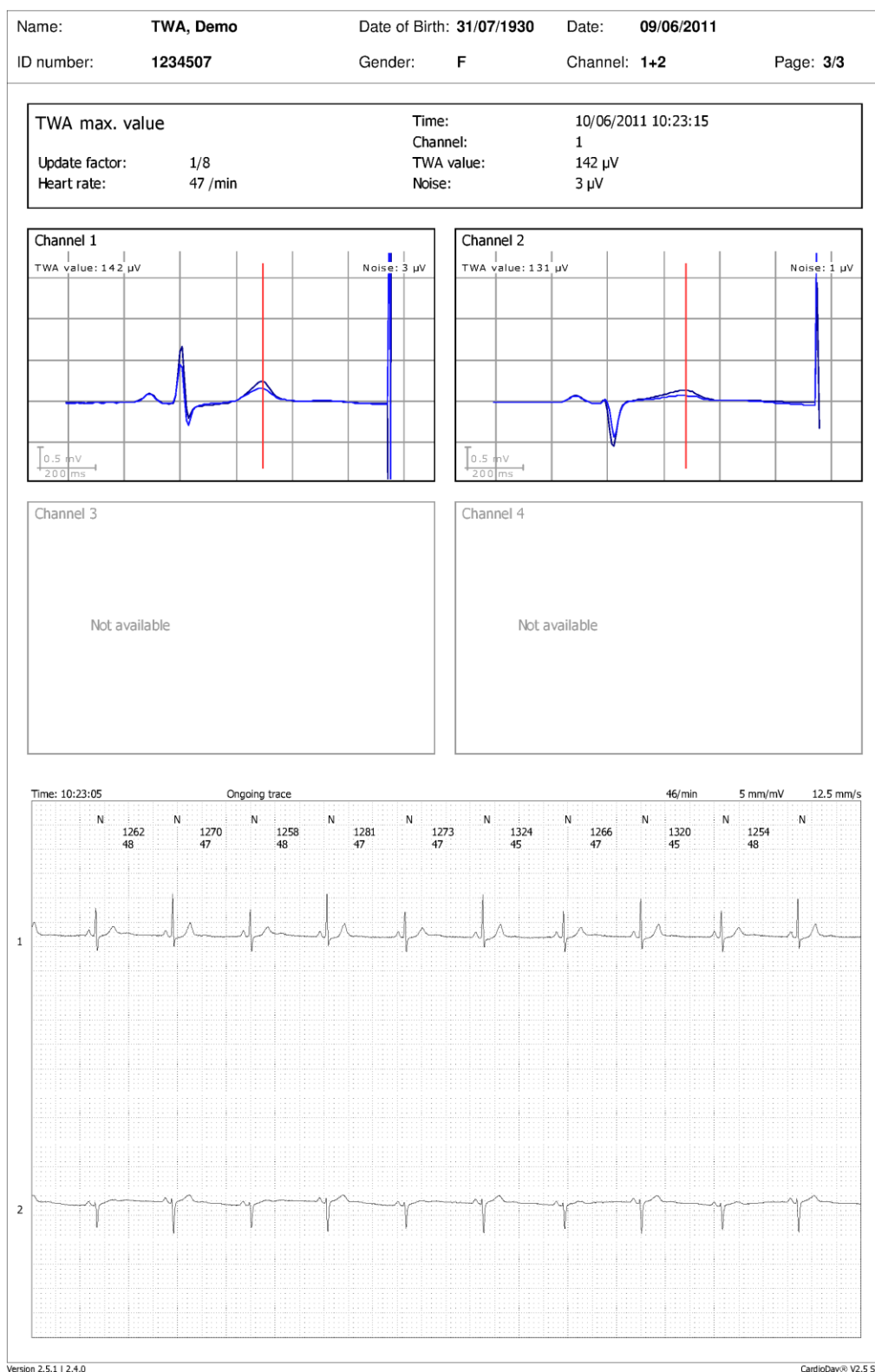
This option prints the TWA values for the selected channels over the analysis time. The noise value is displayed inverted in the same graphic. Furthermore, the heart rate trend over time is shown.



Sample printout of the TWA trend

Print > TWA > ECG

This option prints the TWA maximum value as a numerical value and as a graphic for each available channel. On the second half of the sheet, the maximum TWA value is displayed in the ECG context.



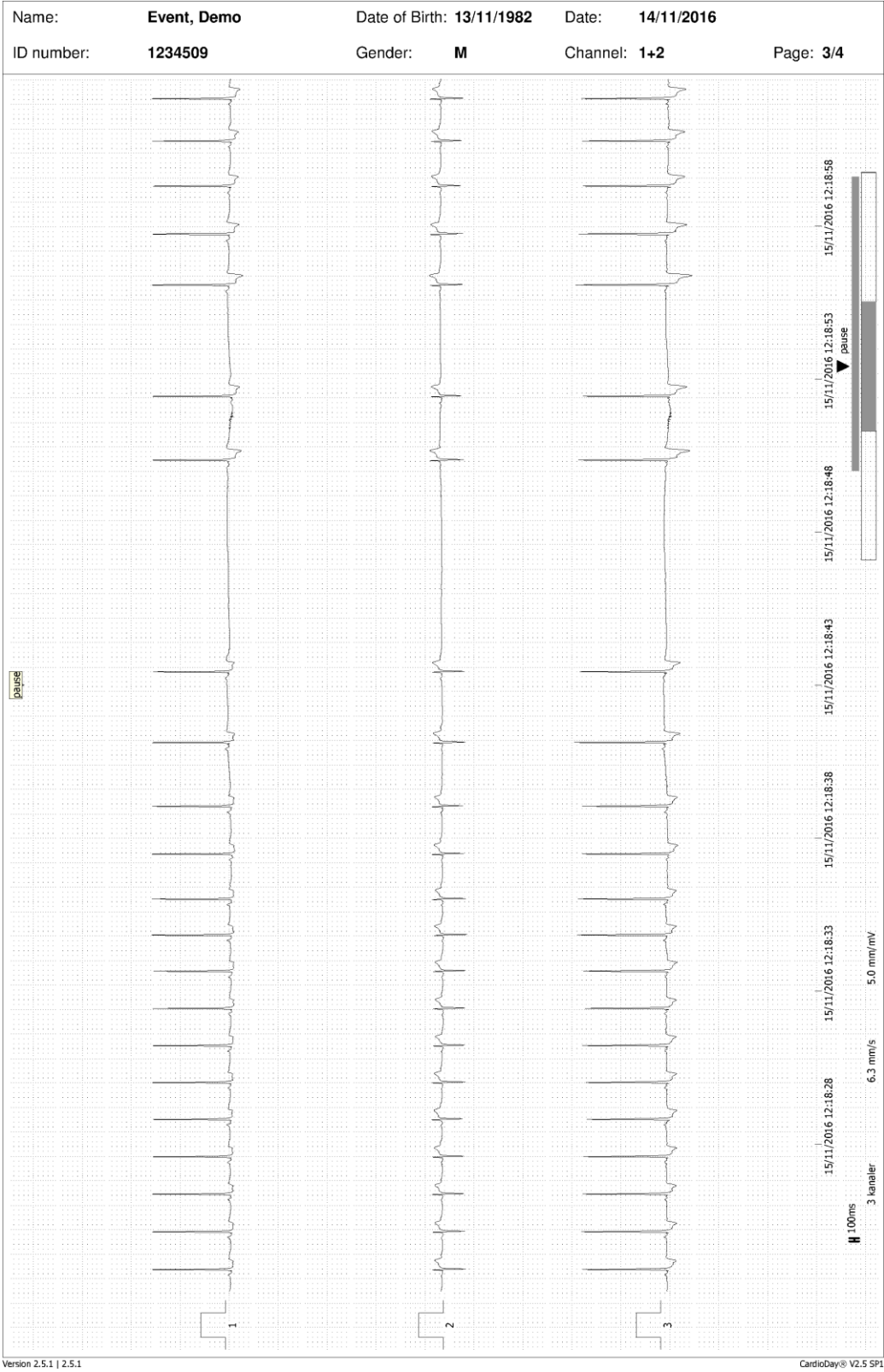
Version 2.5.1 | 2.4.0

CardioDay® V2.5 SP1

Sample printout of TWA > ECG

Print > Event Recorder > Selected Marker

This option displays the ECG waveforms of the markers selected on the **Events** tab. It is selectable only for event recordings recorded with a CardioMem CM 3000 L3 recorder.



Sample printout of the markers selected on an Event recorder

Part II

—

The CardioDay Menus

21

The Recording menu

This menu contains file functions such as ***Open existing recording*** or ***Close recording***, as well as the instruction to ***Exit*** CardioDay.

Recording > Start



This selection opens the start window with the following options:

- ***Hookup (1)***
- ***Transfer patient data (2)***
- ***Download recording (3)***
- ***Download long recording (4)***
- ***Open existing recording (5)***

Option 2 is used to transfer patient information to the recorder or to the CompactFlash memory card used with the CardioMem or SEER 12 ECG recorders before beginning the recording.

The options (1) to (5) are explained in more detail in the section "[Start window options](#)" on page 29.

Recording > Open...

This selection opens an existing ECG recording stored on your PC hard disk without any changes to ***Signal evaluation and analysis parameters***.

Recording > Reanalyze...

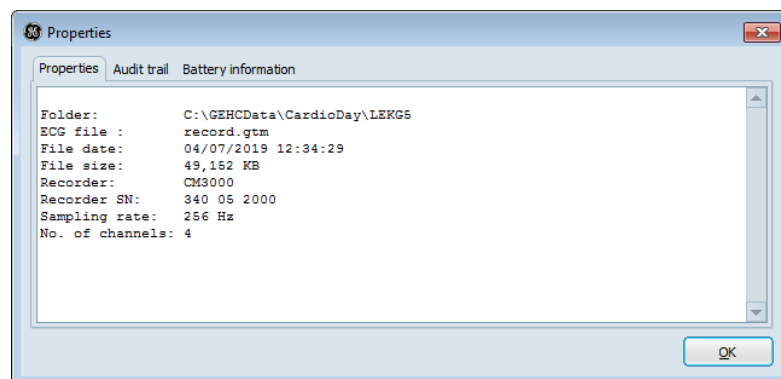
A signal evaluation is repeated. The user opens an existing recording and CardioDay reanalyzes the raw ECG data.

Recording > Patient data...

This selection allows subsequent modifications or additions to be made to the patient data of the currently open recording.

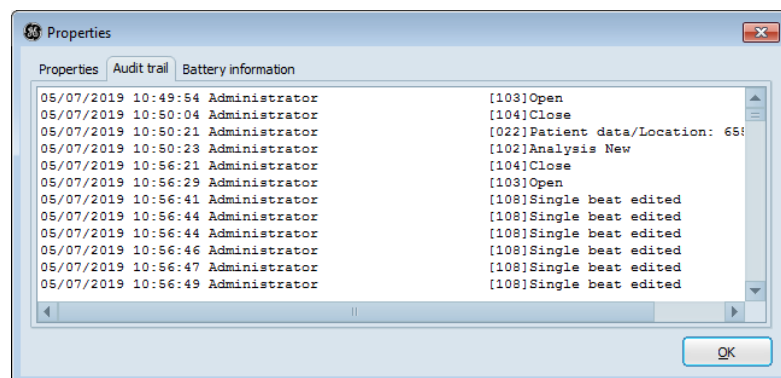
Recording > Properties...

The location and technical details of the recorder used for recording are displayed in the **Properties** tab.



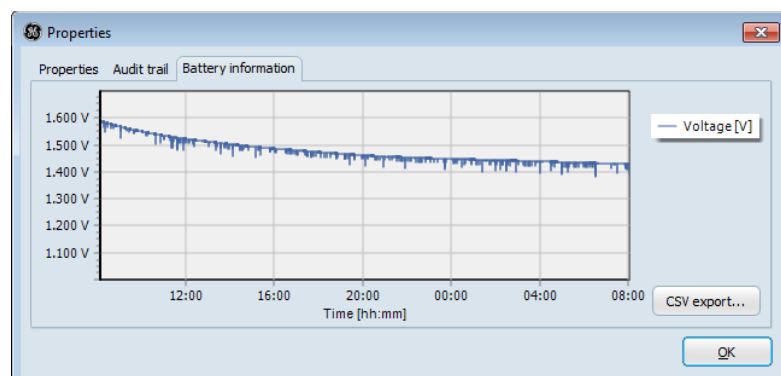
Recording > Properties... > Properties

An evaluation history of the recording is displayed on the **Audit log** sub-tab.



Recording > Properties... > Audit log

Recorder battery information is displayed on the **Battery information** sub-tab.



Recording > Properties... > Battery information

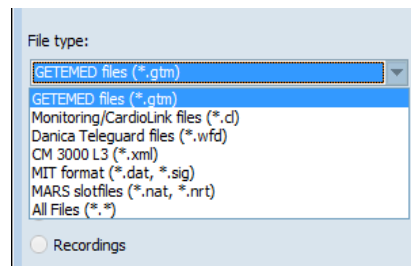
Recording > Close recording

This selection closes the current ECG recording.

Recording > Import...

This selection allows you to

- open recordings that were downloaded using the CardioRead remote download software,
- import recordings that were exported from another CardioDay database,
- import active and archived MARS recordings,
- import recordings that were recorded using the event recorder CardioMem CM 3000 L3, and
- import recordings in MIT format or other available formats depending on the license purchased.



Recording > Import > File type

First, select the file type of the recording to be imported. Then browse to or select the folder where the file(s) to import are located. A simple left click will open the respective folder.

In the list that appears on the right, you can either display the individual files or the patient data of the individual recordings. To do so, select the desired viewing mode.

Click **OK** to import the highlighted recording.

NOTE:

Only select the **Delete file after import** option if you do not want to download recordings longer than 48 hours. For information refer to [“Opening long recordings”](#) on page 47.

Importing MARS Recordings

To import individual MARS recordings into CardioDay, use the following procedure. For information on importing batch recordings, refer to the *CardioDay V2.5 Installation and Field Service Manual*.

1. Select **Recording > Import...**
2. In the **File type** field, select **All Files (*.*)**
3. Select the directory path where the file is located.

A simple left click will open the respective folder.

4. Review the files on the right side of the screen and select the file you want to import.

CardioDay supports the import of .nat and .nrt files.

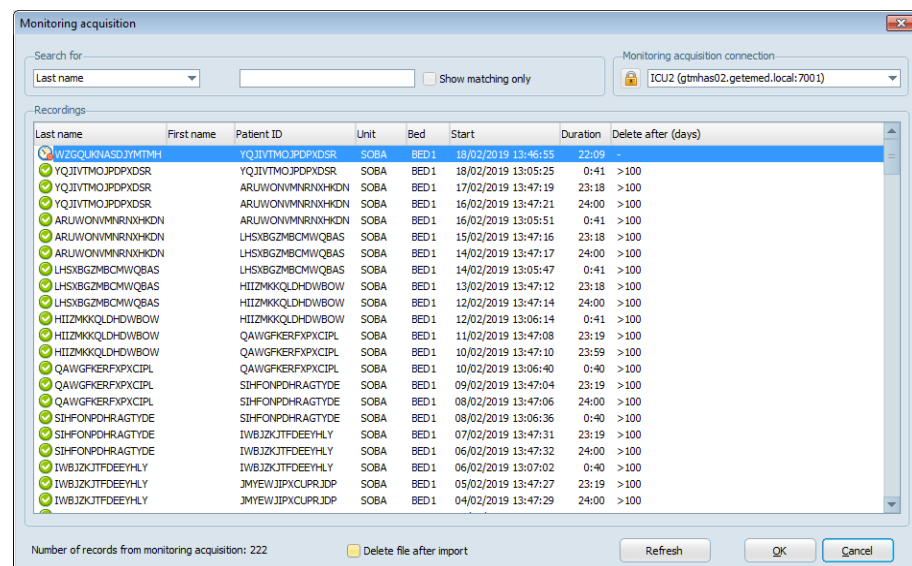
5. Click **OK** to import the highlighted recording file.

Recording > Monitoring acquisition

Selecting this sub-menu will open the **Monitoring acquisition** import list, which is part of the Holter Acquisition Service (HAS) for bedside monitoring acquisition.

NOTE:

The monitoring acquisition function is intended to import ECG signals. It is not possible to import pacemaker data, blood pressure values, or blood gases' measurements possibly also recorded by a monitor.

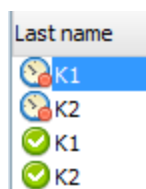


Recording > Monitor Acquisition import list

CardioDay imports ECG data from different GE bedside and telemetry monitors and analyzes these data as Holter ECG recordings if the applicable license option is available and all technical requirements are met.

No additional Holter recorder is required. The ECG signals from the monitors are transferred in blocks of a maximum of 48 hours to the HAS. The ECG signals can then be selected from the **Monitoring Acquisition** import list and downloaded to CardioDay.

The list also includes all running examinations, which can be chosen for immediate import as well. Running examinations are indicated by a watch symbol next to the patient's **Last name** in the list.



Recording > Monitor Acquisition import list, indication of running recordings

If you import a running examination, this currently active recording will be exported and a new recording with the configured block size will start.

The **Refresh** button updates the list with the latest content.

If more than one CARESCAPE Gateway server is set up to be used with CardioDay, they will be displayed in a dropdown list in the upper right of the screen. If you select one, the corresponding recording list, with all available beds and running recordings, will be loaded. If a default Gateway is defined on the **Setup** menu, its list of available beds and running recordings will be loaded automatically when the monitoring acquisition window opens. For setup information, refer to "[Setup > Other options > Monitoring connection](#)" on page 235.

You can sort the import list by **Name**, **First name**, etc., by clicking the respective column heading. Also, you can filter the import list by **Name**, **ID**, or **Unit**. If you check the **Show matching only** check box, you can view all examination blocks of a patient and import the blocks you want.

If you mark an examination block and confirm with the **Enter** key, CardioDay displays the patient list, from which you can select a free storage space or overwrite an existing recording. If you are overwriting an existing recording, you will be warned and asked to confirm the deletion.

You can check the entries in the patient data window. If you click **OK**, the pre-analysis is started. For additional information, refer to "[Signal evaluation and setting of Analysis parameters before downloading the ECG data](#)" on page 34.

Based on a configurable setting on the HAS server, once an import file reaches a threshold age, it will be deleted from the server.

The default setting for the automatic deletion is set to three days. The configuration should be performed by the administrator. For additional information on the installation and configuration of the HAS refer to the *CardioDay V2.5 Installation and Field Service Manual*.

Recording > Delete

This menu opens a window with a list of all ECG recordings currently available in your CardioDay data folder.

NOTICE:

IRREVERSIBLE DATA LOSS - Deletion is irreversible. Recordings cannot be undeleted.

This operation should be performed only by knowledgeable and approved operators.

NOTE:

You can delete recordings individually or in groups. To do so, you can, for instance, search for **Name** and then delete all recordings of a patient.

You may select an ECG recording that you wish to delete by marking it with the mouse or using the **Up** and **Down** arrow keys. If you wish to select several consecutive recordings simultaneously, hold the **Shift** key while selecting the recordings. Once all selections have been made, the recordings can be deleted by clicking the **OK** button. Before actually deleting the recordings, CardioDay asks you to confirm your decision.

Recording > Exit

This command enables you, after confirmation, to exit CardioDay.

22

The Recorder menu

This menu serves for the data exchange between the PC and different types of recorder.

- The **Hookup** function allows you to prepare and start a Holter recording. Depending on the recorder type, the connection for patient data transfer and signal quality evaluation can be established via Bluetooth or USB cable.
- The **Transfer patient data** function is used when no signal quality evaluation is intended during recording preparation.
- The **Download recording** and **Download long recording** functions can be performed via USB cable only.
- The **Download event recordings** function is only used if an event recording from the recorder type CM 3000 L3 is available.

Recorder > Hookup

From the **Hookup** window, you can add new recorders (connect a USB recorder or find additional Bluetooth recorders within range), manage existing recorders, or connect to an existing recorder.

Once connected to a recorder, CardioDay **Hookup** also allows you to:

- transfer patient data from the PC to the recorder prior to starting the recording,
- synchronize the recorder's internal clock with the PC's clock,
- view ECG data (check the patient skin prep, signal quality, amplitude, electrodes, and leadwire continuity) from the recorder on the evaluation PC prior to starting the recording,
- start the recording,

- view ECG data from the recorder online on the evaluation PC during the recording phase, and
- send an event marker signal to the recorder.

The following table shows which recorder types can be connected to the **Hookup** window and which interface is supported for each type.

Recorder type	Bluetooth	USB
CardioMem CM 4000 (with enabled Bluetooth option)	Yes	No
CardioMem CM 3000-12 BT	Yes	Yes
SEER 12	No	Yes
SEER 1000	Yes	No

NOTE:

Bluetooth connection requires the Microsoft Bluetooth stack. Third-party Bluetooth drivers are not supported. The USB connection is established with a standard Mini-USB cable.

NOTE:

The identifier code for a Bluetooth-connected recorder is based upon the unique MAC address of the Bluetooth™ module implemented within the recorder (MAC = Media Access Control, unique network identifier). If a recorder is connected using a USB cable, the first device found is used.

CAUTION:

PROBLEMS WITH WIRELESS DATA TRANSFER – Your own wireless data exchange, as well as the proper functioning of other wireless devices in the vicinity, can be disturbed even if you use approved devices.

If your computer's internal Bluetooth module cannot connect to the recorder, disable the internal module and use the Bluetooth USB adapter.

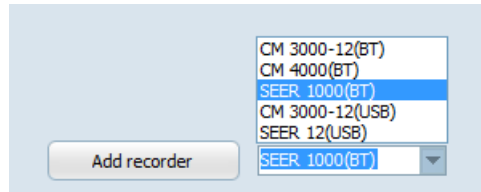
Adding a recorder to the recorder list

The list of recorders in the lower right corner of the **Hookup** window is initially empty. Recorders must be added to this list prior to use in the **Hookup** window.

NOTE:

If the recorder you want to use is already displayed in the list below the patient data form, you can skip to the section [“Establishing a connection to a device already in the recorder list”](#) on page 209.

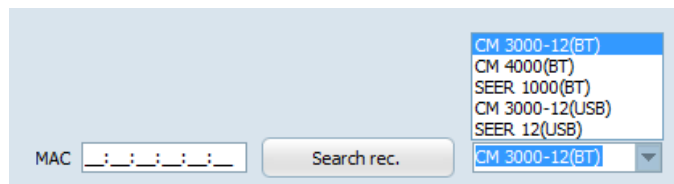
The method of proceeding depends on the selected **Recorder type** and connection method (Bluetooth or USB cable).



Hookup > Recorder selection

Adding a CardioMem CM 3000-12(BT)

For the CardioMem CM 3000-12 BT, an online ECG is possible via Bluetooth or via USB cable. This section explains the connection via Bluetooth. To connect via USB cable, refer to “[Adding a SEER 12\(USB\) or CM 3000-12\(USB\) recorder](#)” on page 207.



Hookup > Recorder type and MAC entry field

1. Select **CM 3000-12(BT)** from the recorder type field at the bottom of the screen.
2. Click the **Add recorder** button.
3. Enter the MAC address located on the back of the recorder into the field provided.
4. Click the **Search rec.** button.

The recorder is now included in the recorder list and is ready for **Connect**.

Adding a CardioMem CM 4000(BT)

For the CardioMem CM 4000, an online ECG is possible via Bluetooth only.

1. Select **CM 4000(BT)** from the recorder type field at the bottom of the screen.
2. Click the **Add recorder** button.
3. Enter the MAC address located in the device user interface under the info section into the field provided.
4. Click the **Search rec.** button.

The recorder is now included in the recorder list and is ready for **Connect**.

Adding a SEER 12(USB) or CM 3000-12(USB) recorder

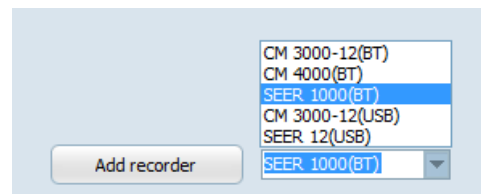
For the SEER 12, an online ECG is possible only via USB. The CardioMem CM 3000-12 BT can be connected via USB or Bluetooth. This section explains the connection via USB. To connect the CM 3000-

12 BT via Bluetooth, refer to “[Adding a CardioMem CM 3000-12\(BT\)](#)” on page 207.

1. Connect the recorder to the computer's USB port using a USB cable.
 2. Depending on your recorder type, select **SEER 12(USB)** or **CM3000-12(USB)** from the recorder type field at the bottom of the screen.
 3. Click the **Add recorder** button
- CardioDay reads the MAC address of the recorder. The recorder is now included in the recorder list and is ready for **Connect**.

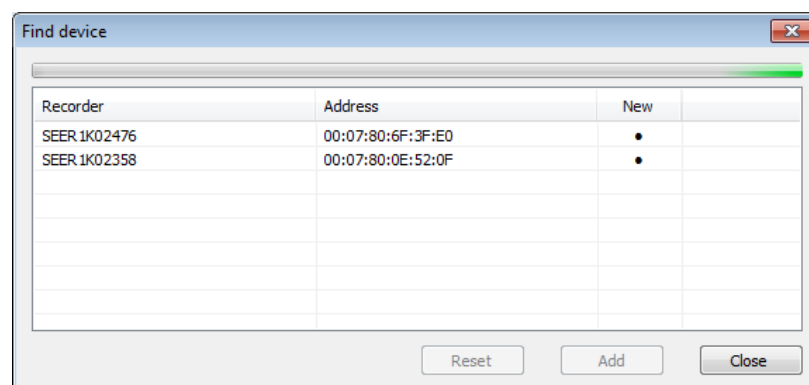
[Adding a SEER 1000 recorder](#)

1. To add a new SEER 1000 recorder, select **SEER 1000(BT)** from the recorder type field.
2. Click the **Add recorder** button.



Hookup > Recorder type

A window opens displaying all SEER 1000 recorders found in the vicinity. Be sure that Bluetooth is enabled on both the PC and the recorder, and observe all information provided in the recorder's manuals. It may take up to a minute to find all of the detectable SEER 1000 recorders within range. SEER 1000 recorders that have been found will be added to the recorder selection list.



Hookup > Bluetooth Find device selection window

The **New** column in the **Find device** list indicates if a recorder has not yet been added to the recorder list.

3. Select the desired recorder from the list.

It is now included in the recorder list on the screen and is ready for **Connect**.

Patient ID	Last name	First name	Connect date	Serial number	Type	MAC
				391 14 02358	SEER 1K	00:07:80:0E:52:0F
				391 14 02594	SEER 1K	00:07:80:0E:50:B8

Hookup > Recorder list

Resetting a SEER 1000 recorder if necessary

Once communication with a SEER 1000 recorder has been established, a protection key, which is automatically generated from the administrator password, is downloaded to the recorder. After that, the recorder can only be accessed by applications that have the same administrator password. If a recorder needs to be reset, use the following instructions.

NOTICE:

Resetting the recorder deletes all the data on the recorder and resets the protection key.

1. Click **Add recorder**.
2. Select the desired recorder in the list.
3. Click **Reset** and confirm.

A message box is displayed when the reset is complete.

Establishing a connection to a device already in the recorder list

If the recorder is already displayed in the list, select the recorder and click the **Connect** button.

When you click the **Beep** button, the currently connected recorder emits an acoustic signal.

Receiving or sending patient data

If there is patient data already stored in the recorder, you can display it from recorders of the CardioMem series in CardioDay by clicking the **Receive** button.

If the SEER 1000 is used, existing patient data are displayed automatically in the patient data form.

While connected to a recorder, you can transfer new patient data to the recorder or edit existing patient data. Click the **Send** button to transfer the new or modified patient data to the recorder connected.

Site and Location

Set the **Site** and **Location** for the recording. The **Site** and **Location** assigned to the current user will be available in the drop-down menu. The default **Site** and **Location** of the current user is selected automatically.

If no default **Site** and **Location** is assigned to a user, **Unknown** is selected by default. You can select any other available **Site** and **Location**. The selection of **Unknown** assigns the recording to any **Site** and **Location** and makes it visible to all users. For details, refer to “[Setup > Site and location administration...](#)” on page 243 and to “[Site and Location management for users and groups](#)” on page 253.

Processing MUSE orders

If your CardioDay is connected to MUSE, a **MUSE orders** button will be available. For additional information refer to “[Setup > Other options > MUSE connection](#)” on page 234.

The screenshot shows the Hookup window interface. On the left, there are two ECG traces (red and green) and a diagram of a human torso with electrode placement. The right side contains a patient data form with fields for Patient ID, Last name, First name, Address, Phone number, Date of birth, Insurance, Insurance code, Referring physician, Indication, Medication, Remarks, Visit number, Order number, Technician, Site, and Location. The **MUSE orders** button is circled in the form. At the bottom, there is a table of patient data and a status bar with buttons for Online, Full screen, SEER 1000 (BT), Transfer PC time, Start rec., Beep, Disconnect, and Close.

Patient ID	Last name	First name	Connect date	Serial number	Type	MAC
1234	7 days	7 days	08.07.2019 17:00	391 14 02476	SEER 1K	00:07:80:6F:3F:E0
1234501	Doe	John	23/07/2019 17:20	391 14 02594	SEER 1K	00:07:80:0E:50:B8
109	Doe	Jane	23/07/2019 14:11	391 14 02358	SEER 1K	00:07:80:0E:52:0F

Hookup window with Muse Orders button enabled

Clicking the **MUSE orders** button will open the list of available Holter MUSE orders which can be transferred to the recorder. To transfer the data, select the desired patient from the order list. The patient information will now be automatically displayed in the patient data form. Select **Send** to transfer it to the recorder.

MUSE orders

Search for: Last name ☐ Show matching only Site: 1 - The first site

Last name	First name	Patient ID	Date of birth	HIS Order number	Priority	Test time
Rethera	Shanna	DP_103F04C9FE	09/06/1961	DO_103F04C605	ROUTINE	12/02/2019 08:49:36
McConnell	Fen	DP_103F04D48A	18/02/2006	DO_103F04D490	ROUTINE	12/02/2019 04:11:08
Flaha	Lierra	DP_103F04D033	31/12/1929	DO_103F04D039	ROUTINE	11/02/2019 18:45:58
Saretti	Aeon	DP_103F04D720	07/12/1991	DO_103F04D727	ROUTINE	10/02/2019 17:21:14
Sarden	Bot	DP_103F04D33D	30/01/1941	DO_103F04D344	ROUTINE	10/02/2019 15:48:05
Dettun	Bot	DP_103F04D1DE	25/01/2017	DO_103F04D1E4	ROUTINE	10/02/2019 13:56:02
Mothma	Deel	DP_103F04CB90	30/12/1963	DO_103F04CB96	ROUTINE	10/02/2019 11:06:48
Voss	Shyon	DP_103F04CE6A	16/03/1964	DO_103F04CE71	ROUTINE	09/02/2019 09:01:54
Rhane	Korynn	DP_103F04D5D8	17/01/1966	DO_103F04D5E0	ROUTINE	08/02/2019 11:12:11
Winkler	Stefan	DP_103A42EA89	03/04/1943	DO_103A42EA8F	ROUTINE	04/02/2019 09:06:27
Thont	Dahn	DP_102D05A62C	24/10/1973	DO_102D05A633	ROUTINE	12/01/2019 20:33:19
Bonga	Loysia	DP_102D05B8E5	15/01/1944	DO_102D05B8EA	ROUTINE	10/01/2019 05:56:07
Hasagaiwa	Carth	DP_1020995B69	06/10/1956	DO_1020995B6F	ROUTINE	20/12/2018 13:30:19
Martano	Numa	DP_1020942C45	24/05/1942	DO_1020942C4C	ROUTINE	19/12/2018 08:44:23
Alateen	Herr	DP_1019F3B619	13/11/1981	DO_1019F3B620	ROUTINE	12/12/2018 00:24:34
Gabbett	Dax	DP_1019E20EC5	14/03/1957	DO_1019E20ECC	ROUTINE	11/12/2018 10:59:58
Rethera	Sabrina	DP_1019E23E44	18/03/1986	DO_1019E23E4B	ROUTINE	10/12/2018 22:50:43
Alateen	Frau	DP_1019F4A00F	14/07/1928	DO_1019F4A015	ROUTINE	10/12/2018 00:16:12
Qualto	Iving	DP_1019E23C7F	01/01/1949	DO_1019E23C84	ROUTINE	09/12/2018 20:44:39
Lekit	Deel	DP_1019709916	03/11/1988	DO_101970991C	ROUTINE	09/12/2018 08:47:14
Yoan	Ziris	DP_1015413656	06/05/1940	DO_101541365D	ROUTINE	04/12/2018 14:21:22
Bendix	Numa	DP_1015418AC3	23/06/1956	DO_1015418AC9	ROUTINE	04/12/2018 13:55:29

Count of orders: 490

Refresh OK Cancel

Muse orders window

After the patient order data has been sent to the recorder, the order will no longer appear in the MUSE orders list.

Recorder settings for a recording, the Options field

If you use a CardioMem recorder, clicking the **Transfer PC time** button will set the clock of the recorder to the current computer time.

If you use a SEER 1000 recorder, the clock of the recorder will be automatically synchronized to the current computer time.

Clicking the **Options** button will open a window where you can select the **Recording duration**.

The battery state is displayed in the **Hookup** main screen on the left-hand side of the electrode placement window. If the symbol is red, it indicates that the battery does not have enough capacity for the selected recording duration. The battery will need to be re-placed.

In addition, for the SEER 1000 recorder, you can also set the **Auto-delete** option and view the **Battery type** displayed. If **Autodelete** is checked, recordings will be deleted from the recorder after they have been downloaded to CardioDay.

Viewing ECG waveforms and checking the signal quality

Next to the patient data you can see the online ECG for signal evaluation. At the bottom right, you can select the channels to be displayed as well as set the speed and the amplitude.

The Recorder menu

Patient ID	Last name	First name	Connect date	Serial number	Type	MAC
1234	7 days	7 days	08.07.2019 17:00	391 14 02476	SEER.1K	00:07:80:6F:3F:E0
1234501	Doe	John	23/07/2019 17:20	391 14 02594	SEER.1K	00:07:80:0E:50:B8
109	Doe	Jane	23/07/2019 14:11	391 14 02358	SEER.1K	00:07:80:0E:52:0F

Recorder > Hookup ECG

Furthermore, for the SEER 1000 recorder, the electrode placement guide is displayed. The recorder automatically detects the type of cable being connected and shows the correct positioning of the electrodes.

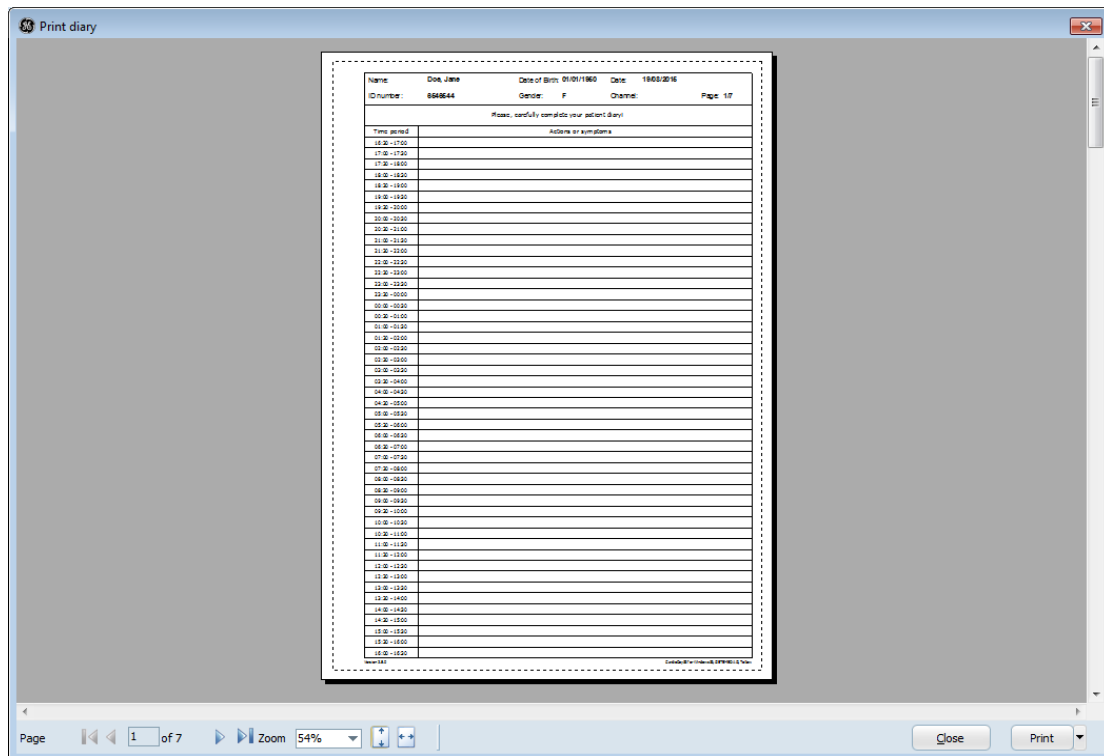
If an electrode is not connected, or if the signal quality is insufficient, this is indicated by a red blinking in the torso and at the respective channel (colored marking of the electrodes).

When you click the **Full screen** button, the display will hide the patient demographic frame and the waveforms will occupy the entire horizontal screen area.

Clicking the **Split screen** button will return to the split screen containing the patient demographic form.

Print diary

When you select **Print diary**, a page can be printed on which the patients can note their performed activities during the recording duration.

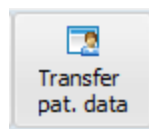


Hookup > Print diary

Recorder > Transfer patient data

The method for transferring patient data varies depending on the type of recorder being connected:

- The recorders of the CardioMem CM 3000 and the SEER 12 series use memory cards that can be removed. For downloading recording and patient data, a CompactFlash card reader is required.
- The recorders of the CardioMem CM 4000 and the SEER 1000 series have non-removable memory cards. For downloading recording and patient data, the recorder is connected to the PC via the integrated USB interface.



Before starting the recording, the **Patient data** can be transferred to the memory of the recorder.

If you select **Transfer patient data**, the patient data window opens.

When CardioDay is connected to an Electronic Medical Record (EMR) with GDT interface, the data of patients transferred from this system may already be entered in the patient data window and are not editable.

If your CardioDay is connected to MUSE, you can receive orders from MUSE. Clicking the **MUSE Orders** button will open the list of

MUSE orders from which you select a patient. The patient selected is automatically included, together with the existing data, in the corresponding entry fields of the form. After this, the patient selected is not listed anymore in the **MUSE Orders** list.

The screenshot shows a 'Patient data' window with the following fields and controls:

- Patient ID:** Text input with value '12345'.
- Last name:** Text input with value 'Doe'.
- First name:** Text input with value 'Jane'.
- Address:** Text input.
- Phone number:** Text input.
- Date of birth:** Text input with value '09/05/1982' and a calendar icon.
- Insurance:** Text input.
- Insurance code:** Text input.
- Referring physician:** Dropdown menu.
- Indication:** Dropdown menu.
- Medication:** Dropdown menu.
- Remarks:** Text input.
- Visit number:** Text input.
- Order number:** Text input.
- Technician:** Dropdown menu.
- Site:** Dropdown menu with value '(Unknown)'.
- Gender:** Radio buttons for 'Female' (selected), 'Male', and 'Unknown'.
- Pacemaker:** Dropdown menu with value 'No PM'.
- Processed by:** Dropdown menu.
- Buttons:** 'Options', 'Print diary', 'MUSE orders', 'OK', and 'Cancel'.
- Recorder Models:** Radio buttons for 'CM 3000 / SEER 12' and 'CM 4000 / SEER 1000' (selected).

Window for patient data transfer

Clicking the **Options** button will open a window where you can set the **Recording duration**. In addition, for the SEER 1000 recorder, you can also set the **Autodelete** option and the **Battery type**. If **Autodelete** is checked, recordings will be deleted from the recorder after downloading to CardioDay. For details, refer to [“Setup > Site and location administration...”](#) on page 243 and to [“Site and Location management for users and groups”](#) on page 253.

Recorder > Download recording or Download long recording

You can find the information in Chapter 3, [“Downloading ECG data”](#).

Recorder > Download event recording

NOTE:

Event recordings that have been recorded using the CardioMem CM 3000 L3 recorder are not downloaded directly

from the recorder but are imported. For further information, please refer to the section “[Recording > Import...](#)” on page 201.

Event recordings that have been recorded using the CardioMem CM 100 XT recorder can be downloaded directly from the recorder:

1. Select the **Event recorder** symbol to open the **Import recordings** window.
2. Select **CM 100 XT** from the **File type** menu.
3. Review the **Recorder information** and the **Current setup**.
4. Select **OK**.

The recorded events will be downloaded.

23

The Export menu

This menu allows you to export data using the **Print to file** or **HRV data export** functions.

Export > Print to file ...

CardioDay can export the selected printout options for ECG recordings in portable document format (PDF). The setting for **File printer name** in the menu [Setup > File path](#) (see page 228) determines which format is created. The contents of the archived files depend either on the print selection saved for each recording or on the current default. For additional information, refer to “[Default and customized print selection templates](#)” on page 154.

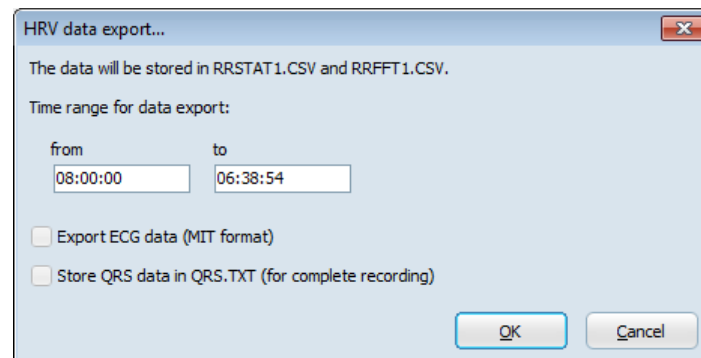
NOTE:

You may select a single recording or a number of recordings simultaneously.

You may select an ECG recording by marking it with the mouse or using the **Up** and **Down** arrow keys. If you wish to select several consecutive recordings simultaneously, hold the **Shift** key while selecting the recordings.

Export > HRV data export

Heart rate variability data, for both the time and frequency domains, are stored in two separate files in the patient's subdirectory.



HRV data export window

Before exporting the data, you may select in which time range within the complete recording you are interested.

Also, you may determine whether or not the QRS trigger times for the complete recording are stored in a QRS.TXT file. If this box is ticked, a *.txt file is created which lists the time, the class characteristic, a possible link to an event, and the heart rate for each QRS complex.

The **Export ECG data (MIT Format)** option serves for storing the raw data of the complete recording in the MIT data format. In this process, two files are stored in the CardioDay data directory: <patient name>.dat and <patient name>.hea.

In the same way, you can export data also in the CSV format and the XML format.

24

The Archive menu

The **Archive** menu enables easy archive administration of your raw data recordings and analysis results (**Archive**, **Restore**, **Delete**).

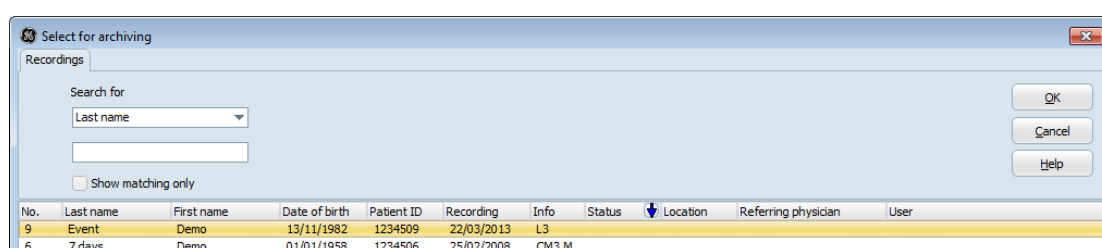
Once the data has been archived, you need to restore it before it can be reviewed again.

For information on **Archive** configuration settings, refer to “[Setup > Other options > Archive](#)” on page 230.

Selecting for archiving

Open the **Archive** menu and select the recordings to be archived from the recording list. If you enter a patient’s name, the respective line is found automatically.

The data will be compressed and stored in the directory set as the archive file path. For information on the archive file path refer to “[Setup > Other options > Archive](#)” on page 230.



Select for archiving

Selecting for Restoring

If you want to retrieve data from your archive, you will need to restore them first. For the **Restore** function, you can select via **Filter** the search criteria **Last name**, **Patient ID**, and **Referring Physician**. You can also select different time values as search criteria for the recording to be restored: the time a recording was started (**Start of recording**), the time a recording was archived (**Archive**), or the time a recording was analyzed (**Analysis**).

Last name	First name	Date of birth	Patient ID	Recording	Location	Storage	Folder
AFib	Demo	21/07/1913	1234502	03/03/2015 08:00:00		18/02/2019 15:34:03	C:\GEHCDData\CardioDay\Archive\
Doe	John	24/08/1932	1234501	01/03/2014 08:00:00	ICU1	18/02/2019 15:33:52	C:\GEHCDData\CardioDay\Archive\

Select for restoring

Select a recording from the **Restore recordings** list and click **OK**. The recording will be restored in your CardioDay database.

Deleting recording(s) from the archive

Single or multiple recordings can be deleted from the archive.

Select the **Archive > Delete** menu to display the archived recordings.

For the **Delete** function, you can select via **Filter** the search criteria **Last name**, **Patient ID**, and **Referring Physician**. You can also select different **Time** values as search criteria for the recording to be restored: the time a recording was started (**Start of recording**), the time a recording was archived (**Archive**), or the time a recording was analyzed (**Analysis**).

Select one or multiple recordings and click **Delete**. When prompted to confirm the deletion, click **OK**.

25

The Extras menu

In the **Extras** menu, you can start a reanalysis of events without changes to the QRS classification, you can start a printout of the current screen, and you can create the 12-channel markers.

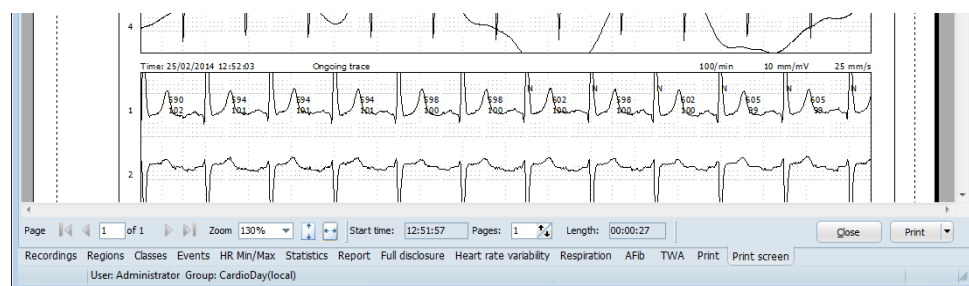
Extras > Reanalyze events...

When you select this option, you are first asked if you wish to change any analysis parameters. If you answer with yes, a window opens allowing you to make the appropriate changes. If you answer with **No**, the event analysis is carried out with the original parameter settings.

Extras > Print screen

This option is not a hard copy of the current screen contents. Instead, this menu option enables you to first preview and then print a hard copy associated with the current screen contents.

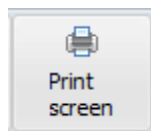
For example, if you are currently on the **Report** tab, then the printout will be the report. If, on the other hand, you are currently on the **Classes** tab, then the window will open with an ECG in a fixed setting of 25 mm/s.



Settings for the screen printout in the print selection

In the left part of the line below the waveform representation, you can choose the view of the print selection: By entering a value in the **Zoom** field or by clicking the blue symbols you can set the enlargement or reduction in percent.

Please enter how many **Page(s)** you want to print.



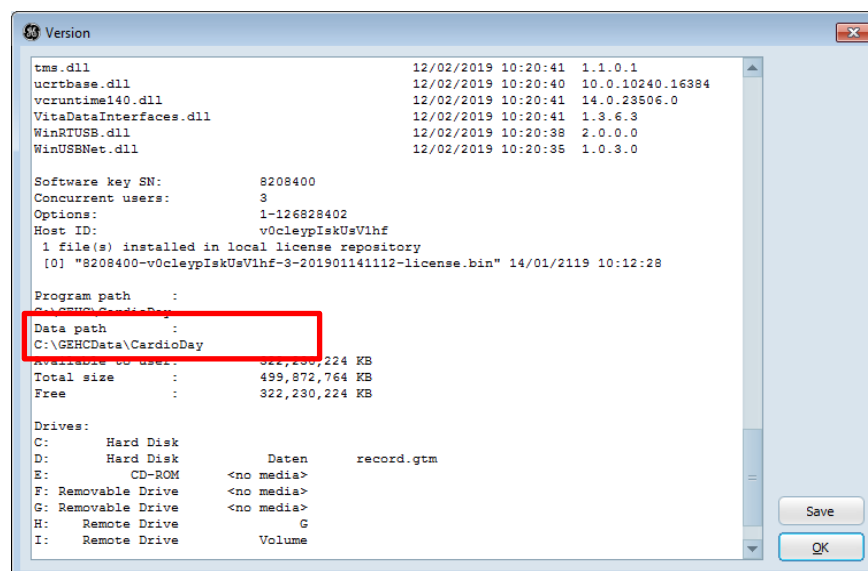
NOTE:

If you call up this option by clicking the **Print screen** symbol in the tool bar, the screen content will be printed without print preview.

Extras > Create 12-channel markers...

In this dialog, you can edit an AutoCreateMarker.txt file used by CardioDay for the 12-channel module. The purpose of this file is to create markers in 12-channel recordings automatically. A marker definition consists of seven fields, as explained by an example in the dialog.

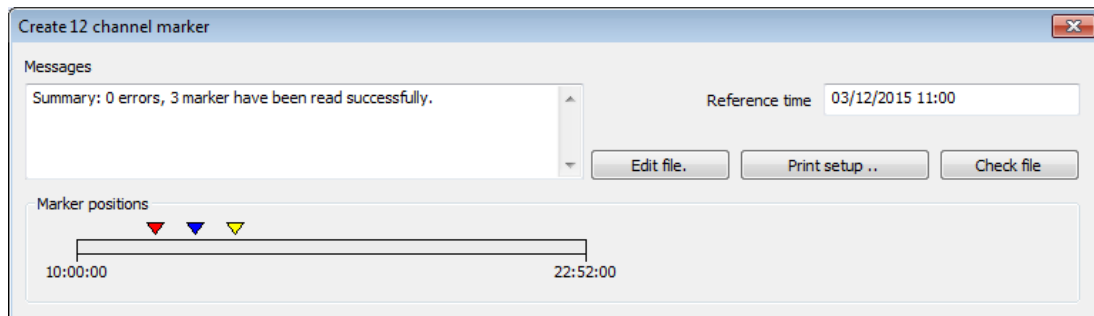
To locate your data path, select **Help > Version** and find the Data path variable near the bottom of the window.



CardioDay data directory in the Help > Version sub-menu

Please note:

- Only one marker can be defined for a given time/time offset.
- The absolute/calculated marker time must be within the scope of the recording.



Create 12-channel marker

Example:

(The “;” character is used to denote the start of a comment.)

; Create marker at 04:00 AM

; | Use reference time field

; | | 5 s pre/post time

; | | | Centered

; | | | | Perform measurement

; | | | | | Color

; | | | | | | Name in marker list

; | | | | | | |

04:00 n 5 m y red Marker1

“n” stands for No.

“y” stands for Yes.

26

The Setup menu

The **Setup** menu allows you to configure certain features of CardioDay.

Setup > Screen, Scale, and Colors

NOTE:

If some of the screen text is not visible, the most likely cause is that the font size option of your Windows desktop is set to large fonts. In this case, please change the setting to small fonts.

If you notice that the ECG grid shown in the **Classes** window on your screen is not scaled correctly, carry out the steps described below.

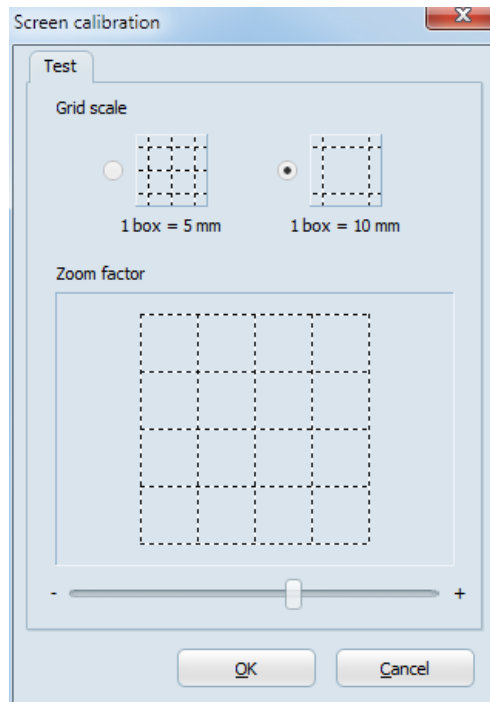
Unfortunately, there is no general solution for plotting a standardized grid on the computer screen. Factors, which influence the final size, include the size and resolution of the screen at hand. To solve this problem, CardioDay offers the possibility of scaling the grid so that standardized sizes, such as 25 mm/s and 1 mV/cm, result. To scale the grid, go first to the **Setup > Screen > Scale** menu.

Before you adapt the scale you can select between two different box sizes.

- The icon with the larger box will lead to a box measure of 1 mV and 400 ms (for a 25mm/s and 10 mm/mV display).
- The icon with the smaller boxes will lead to a box measure of 0.5 mV and 200 ms (for a 25mm/s and 10 mm/mV display).

By adjusting the zoom factor you can increase or decrease the size of the box and the waveform displayed on the screen.

The Setup menu

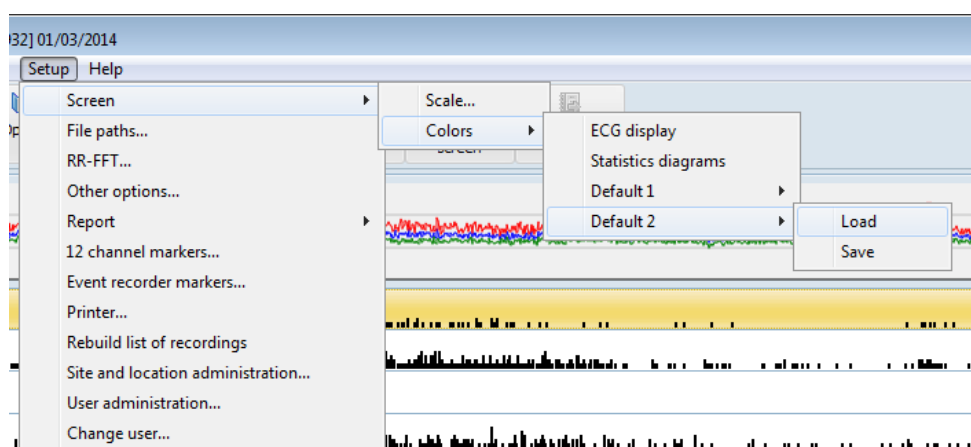


Window to calibrate the grid size

Using the mouse, move the slide control displayed until you measure, for the larger box selection, 10 mm x 10 mm or for the smaller box selection 5 mm x 5 mm.

Once the scale has been adjusted, the settings are automatically saved. The scale does not need to be readjusted each time the program is started. However, if you connect a new screen to your computer or change the resolution in any way, then you will need to manually recalibrate the scale factor again.

This sub-menu also gives you the opportunity to change the colors of the individual ECG, the background grid, and, if present, the impedance plethysmogram curve. Alternatively, you may select a default color set.

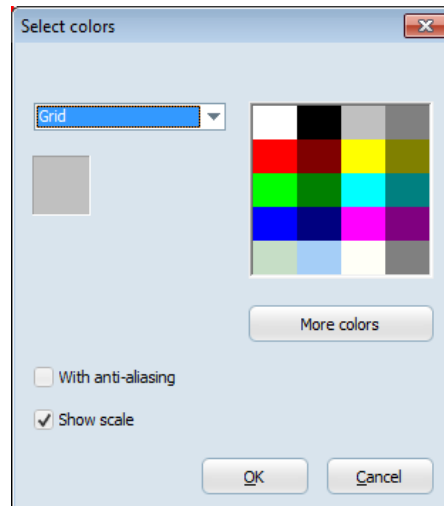


Setup > Screen options

NOTE:

Most of the screenshots presented in this manual were generated using default 2.

With regards to the ECG display, you may select colors for the ECG waveforms, the background grid, the vertical trigger markers, and individual colors for the various QRS morphologies, i.e., color-coded beats.

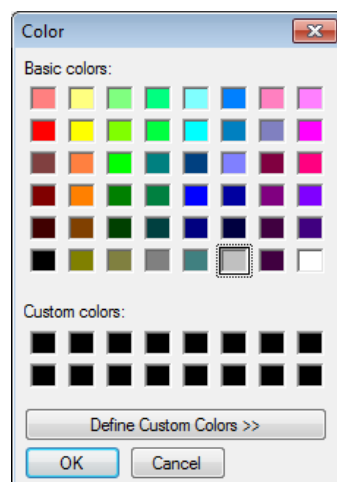


Select Colors

If you select the **With anti-aliasing** option for smoothing the ECG waveforms, any “staircase” effects will be eliminated on the **Classes** and **Events** tabs.

If you select the **Show scale** option to include the scaled grid, the ECG is displayed in front of a grid corresponding to the criteria set for time and amplitude.

With regards to the statistic diagrams, you may select the colors of 4 curves. Furthermore, you may choose the color of the selectable background heart rate curve in the **Other options** menu.



Setup > Screen color selection

Setup > File path...

This option allows you to set the following:

- The directory to which patient data are exported
- The directory from which patient data are imported
- The format, character set, and line length of the import/export data file

The format refers to different export locations like MUSE, GDT interface, or WorklistCommander. For additional information, refer to the *CardioDay V2.5 Installation and Field Service Manual*.

- The directory for **Print to file** results
- The name of the file printer/driver (e.g. integrated PDF Printer or pdfFactory)
- The file name format, extension, and name variables of the print file

Path information

Patient Data import/export

Path for patient data import: D:\Temp2\gdt

File name: patient.gdt

Path for patient data export: D:\Temp2\gdt

File name: result.gdt

Patient data import/export: format: 0

Patient data import/export: char set (0: Windows, 1: ASCII/DOS): 0

Patient data export: Line length (0: no word wrap): 0

Export file name arguments (id, name, firstname, birth, recdate, datetime): id

Export file name format: %s

Print to file

Target folder for PDF printouts: C:\GEHCData\CardioDay\Archive

File printer name: Integrated PDF Printer

File print file name arguments (id, name, firstname, birth, recdate, datetime): id, name, recdate

File print file name format: %s_%s_%s

OK Cancel

Window for setting directory paths

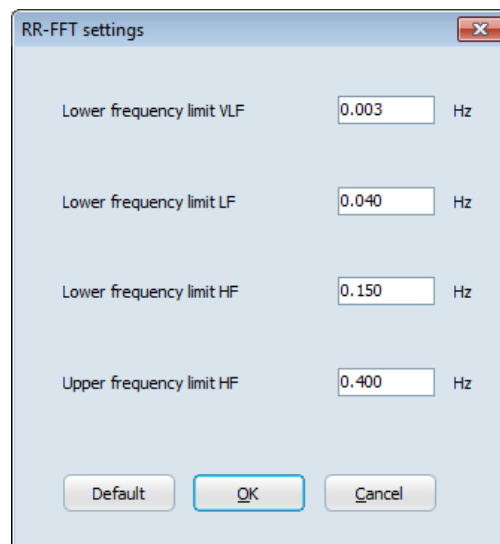
Enter the directory paths for exchanging patient information data in the top two lines of the window.

The **Patient data import/export format** option allows to set the desired path for import and export by selecting a number. For information refer to the *CardioDay V2.5 Installation and Field Service Manual*.

The **Print to file** parameters can be entered here. These files can be generated one by one for single printouts clicking the **PDF** button. (For additional information, refer to “[Configuring a PDF file destination](#)” on page 154.) Also, you can generate several files at a time by using the **Export > Print to file** menu.

Setup > RR-FFT options

This menu opens a window that allows you to adjust the frequency limits used by the Heart rate variability fast Fourier transform (RR-FFT) calculations on the **Heart rate variability** tab and by the sympathetic innervations index calculations in the FFT area of the **Statistics** tab.



Setup > RR-FFT options

Setup > Other options

The **Other options** window has tabs that provide access to the following options:

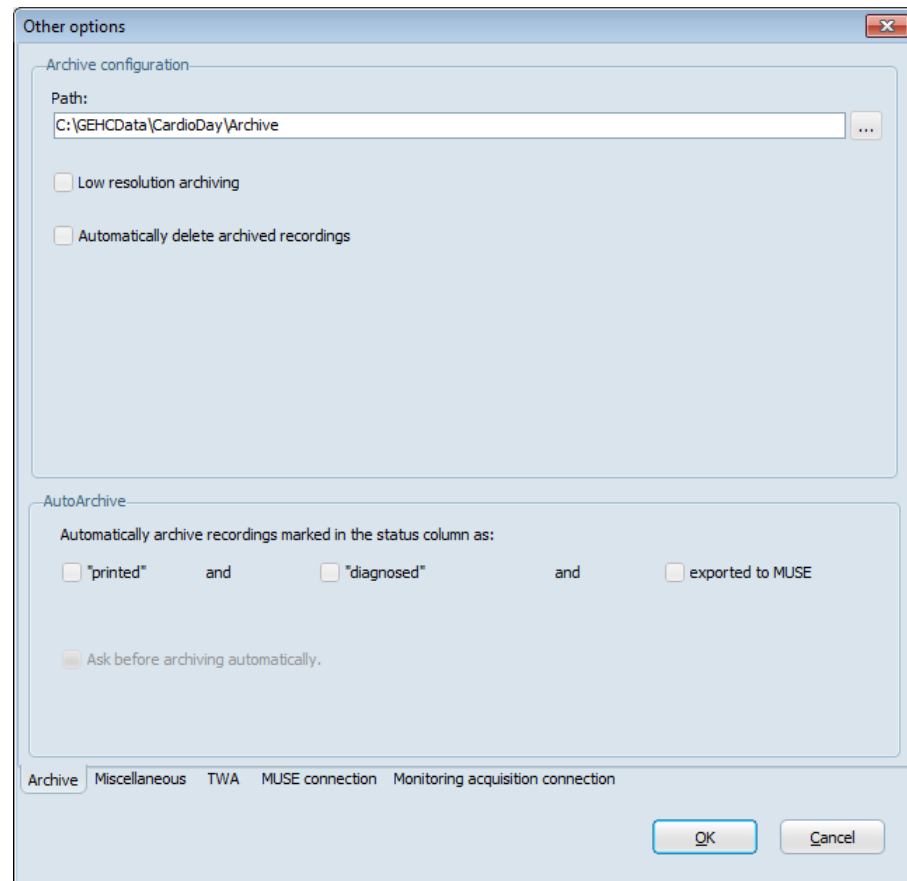
- **Archive**
- **Miscellaneous**
- **TWA**
- **MUSE connection**
- **Monitoring acquisition connection**

Setup > Other options > Archive

The **Archive** tab allows you to set where and how the archived recordings will be stored.

NOTE:

Recordings that are not yet printed or diagnosed can be archived manually.



Setup > Other options > Archive

Field	Description
Path	Defines the location where the archived recordings will be stored.
Low resolution archiving	Reduces file sizes by lowering the resolution of archived files. However, if a recording is archived with this setting enabled, the quality of the waveform data is affected. It will not be possible to restore the waveform data to its original fidelity.
Automatically delete archived recordings	Deletes recordings from the CardioDay database after they have been successfully archived. If required, archived recordings that have been deleted can be restored from the archive.
Automatically archive recordings marked in the status column as	Defines those statuses for which recordings are automatically archived. Options are printed , diagnosed , and exported to MUSE . When a recording's status changes to match all of the selected status values, it will be archived automatically.

Setup > Other Options > Miscellaneous

The **Setup > Other options > Miscellaneous** tab allows you to change additional settings for your individual evaluation procedure.

The screenshot shows the 'Other options' dialog box with the 'Miscellaneous' tab selected. The dialog contains the following sections and settings:

- Statistics:**
 - ☒ Heart rate as background
 - Waveform color... (button) [Color swatch]
- Heart rate diagram:**
 - ☒ With minimum and maximum heart rate
 - ☐ not for B/W printouts
- Event display:**
 - ☒ With marker frame
 - Frame color (button) [Color swatch]
- ECG strip:**
 - Default time axis: 25 mm/s (dropdown)
- Event sorting:**

	Duration	Heart rate
Sorting of VTach	☒	☐
Sorting of SVTach	☒	☐
- Open dialog:**
 - ☐ The next recording which has not been marked as printed will be selected
- ECG analysis:**
 - ☐ SVE Tachycardia need not begin with an SVE event
 - ☐ SVE's within an SVE Tachycardia are marked as SVE's
- Title bar:**
 - ☐ With parameter set that has been used for the analysis
- Recording cache:**
 - Number of cache files: 6 (1..100)

At the bottom, there are tabs for Archive, Miscellaneous (selected), TWA, MUSE connection, and Monitoring acquisition connection. There are also OK and Cancel buttons.

Setup > Other options > Miscellaneous

Statistics

Using the **Heart rate as background** check box, you can select whether or not the heart rate trend curve should be blended into the statistic diagrams. The **Waveform color** button allows you to select the color of the heart rate curve.

Heart rate diagram

Check the **With minimum and maximum heart rate** check box to include the minimum and maximum heart rate curves with the actual heart rate trend curve. The heart rate trend is the average heart rate measured over a 1-minute interval. The minimum heart rate curve shows the minimum value calculated as a moving average over 10 beats during the same 1-minute interval. The maximum heart rate curve shows the maximum value, again calculated as a moving average over 10 beats during the same 1-minute period.

If you check the **not for B/W printouts** check box, minimum and maximum heart rate will not be displayed in black and white printouts.

Event display

The **With marker frame** check box determines whether a box will be drawn around the section of the ECG that corresponds to the event selected on the **Events** tab. The **Frame color** button determines the color of that box.

ECG strip

The **Default time axis** field determines the default display speed when opening or downloading a recording. This setting becomes active the next time a recording is opened or downloaded.

Event sorting

This option allows you to set which criterion, either **Duration** or **Heart Rate**, you want to use for sorting the events **VE Tachycardia** and **SVE Tachycardia** with keyboard navigation of the **Events** tab.

Open dialog

When this option is selected, the cursor automatically jumps to the first recording in the list of patients that has not been marked as printed. If not selected, the cursor jumps to the top of the list.

Title bar

When this option is selected, the default parameter set used for the analysis, along with the patient name, is displayed in the title bar at the top of the window.

ECG analysis

For your ECG analysis, you can select on the following options:

- **SVE Tachycardia need not begin with an SVE event**
- **SVE's within an SVE Tachycardia are marked as SVE's**

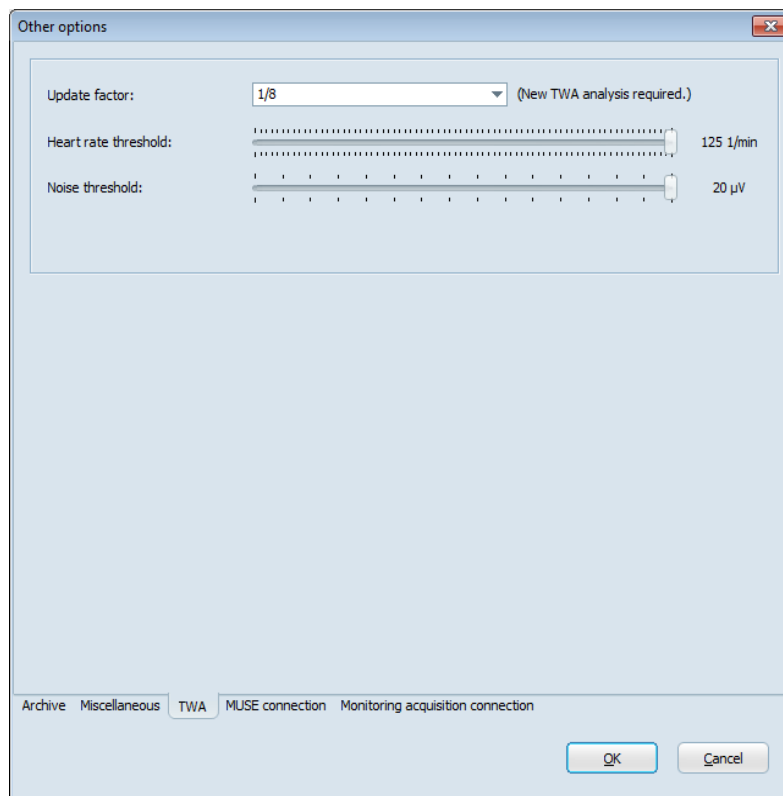
Recording cache

This option determines the **Number of cache files**.

For better performance, a number of recordings can be cached in an uncompressed format on the hard disk. A default of 6 is already set. In this case, the last 6 recordings are loaded in an automatically generated intermediate disk location to enable faster access. Depending on your hard disc storage capacity, you can select a higher value.

Setup > Other options > TWA

The **Setup > Other options > TWA** tab allows you to set parameters for the TWA analysis.



Setup > Other options > TWA

Set the **Update factor** for the averaging of the even and odd beats. Default is 1/8. The higher the denominator, the slower the averaged ECG follows changes in the incoming signal.

Set the maximum **Heart rate threshold** and **Noise threshold**. If the heart rate or noise exceeds the corresponding value, no analysis is performed for this section.

Setup > Other options > MUSE connection

The **Setup > Other options > MUSE connection** tab allows you to configure the connection between CardioDay V2.5 and the MUSE Cardiology Information System.

As a prerequisite for receiving MUSE orders in CardioDay, the MUSE API (Application Programming Interface) needs to have been purchased and licensed.

Also, the communication with the MUSE API needs to be configured. For additional information refer to the *CardioDay V2.5 Installation and Field Service Manual*.

The screenshot shows a window titled 'Other options' with a close button in the top right corner. The window contains several input fields and a section for a report. The fields are: Host (muse9demo), Port (8100), Protocol (radio buttons for HTTP and HTTPS, with 'Validate certificate' checked), Name (test), Password (masked with dots), and Site number (1). Below these fields is a section titled 'Report (Print)' with a checkbox 'Exclude diagnosis from printed report' which is unchecked. Below the checkbox is a text area labeled 'Excluded diagnosis hint message' containing the text 'The report was exported without diagnosis.' At the bottom of the window are tabs for 'Archive', 'Miscellaneous', 'TWA', 'MUSE connection' (which is selected), and 'Monitoring acquisition connection'. There are 'OK' and 'Cancel' buttons at the bottom right.

Setup > Other options > MUSE connection

Enter the necessary information in the following fields:

- **Host:** Host name or IP address by which the MUSE API can be accessed.
- **Port:** Port by which the MUSE API can be accessed. Default port: 8100.
- **Name:** User name of the MUSE account under which the communication with the MUSE API takes place.
- **Password:** Password of the MUSE account under which the communication with the MUSE API takes place.
- **Site number:** ID of the MUSE site from which the examination orders are to be retrieved.

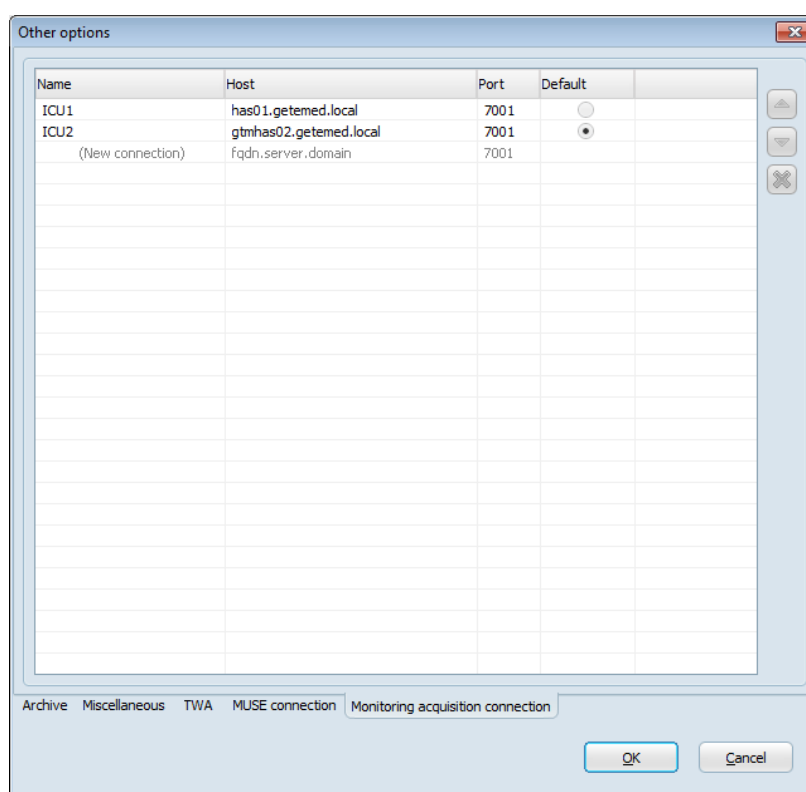
- **Exclude diagnosis on printed report:** If enabled, the diagnosis text entered on the **Report** tab will be excluded from the printed or pdf report. A message will be printed instead of the diagnosis.
- **Excluded diagnosis hint message:** You can select and/or write the hint message that is displayed instead of the diagnosis text if the diagnosis has been excluded from the printed report using the previous setting.

Consult with your local GE Healthcare Service Representative or MUSE System Administrator for proper MUSE system configuration settings.

Setup > Other options > Monitoring connection

The **Setup > Other options > Monitoring connection** tab allows you to identify the **Name**, **Host**, and **Port** of up to 10 servers used by the Holter Acquisition Service (HAS). If desired, one of the servers can be set as default in order to automatically load the recording list when importing monitoring data as described in “[Recording > Import...](#)” on page 201.

Other configurations can be done by the administrator using the HAS tool. For further information, refer to the *CardioDay V2.5 Installation and Field Service Manual*.



Setup > Other options > Monitoring acquisition connection

Setup > Report

The report is comprised of two parts, **Summary** and **Diagnosis**.

The **Summary** is software-generated according to the report template for the respective recording type. You should not edit the summary manually.

The report templates available for customizing are listed in the **Setup > Report** menu. You find the necessary information in “[Customizing and saving report templates](#)” on page 236. You can further customize the summary using script programming as explained in “[Setup > Report > Advanced > Narrative report](#)” on page 240.

The **Diagnosis**, below the **Summary**, is entered manually. You can use the text processing tools explained in “[Setup > Report > Advanced > Text modules](#)” on page 239 and in “[Setup > Report > Advanced > Word- and phrase auto-completion](#)” on page 241.

Customizing and saving report templates

When a report is generated, CardioDay automatically selects the report template based on the recording type and the report's purpose, e.g., whether the recording is a pacemaker recording and whether the report is to be exported to a hospital information system.

Using the variables listed in the appendix of this manual, you can edit the content of the report summary. You can store additional customized report templates for further use.

Clinic

Cardiology

Holter ECG

Referred by:

Indication:

Medication:

Comments:

Start of recording: 25/02/2016 12:42, Duration: 20:15 h

S U M M A R Y

QRS Complexes: 104638 Noise: 1

VENTRICULAR EVENTS

Ventricular escapes: 12

PVC (Prematurity < 90 %): 292

Bigeminy: 0

Couplets: 0

Triplets: 0

VE Runs: 0

-fastest: bpm at

VE Tachycardias (>4): 0

-longest: s at

-fastest: bpm at

SUPRAVENTRICULAR EVENTS

SVE (Prematurity < 80 %): 83

SVE Tachycardia (>120 1/min): 0

-longest: s at

-fastest: bpm at

ARRHYTHMIA

Arrhythmias (Delay > 140 %): 252

-longest: 1.30 s at 06:21

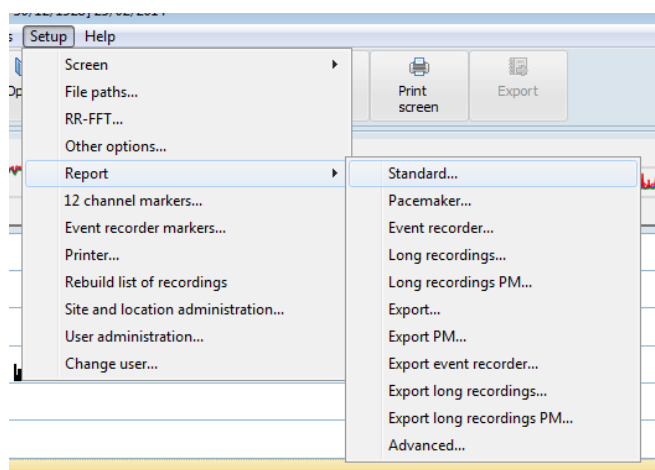
Bradycardias (< 50 1/min): 0

-longest: bpm at

-fastest: bpm at

Summary of the Report

Every **Setup > Report** sub-menu opens a window where you can open the respective template as RTF file with Microsoft WordPad.



Setup > Report

The following default report templates are installed:

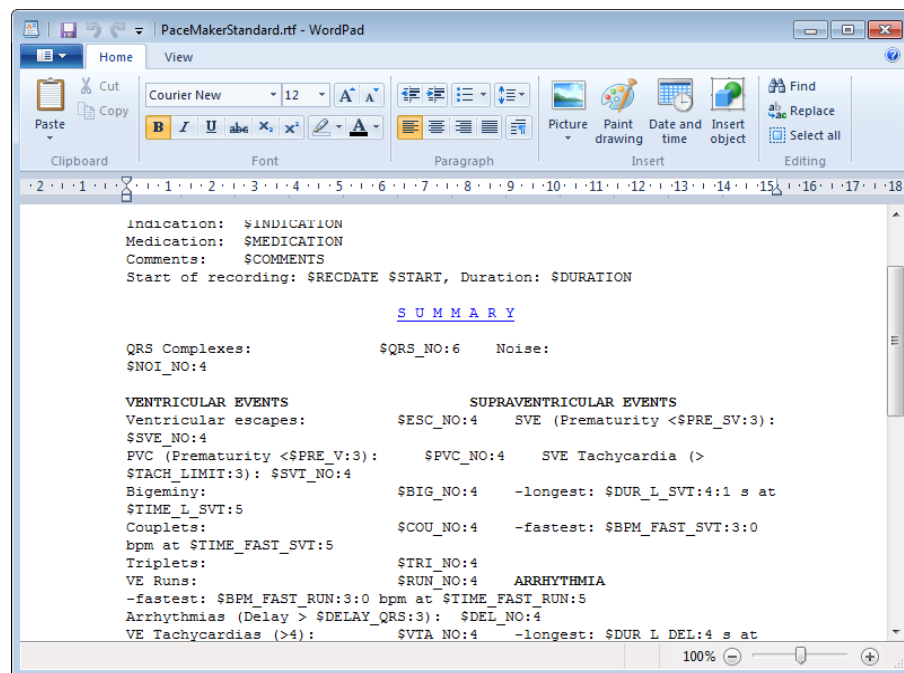
Report template	Function
Standard	Standard report layout
Pacemaker	Standard report layout for pacemaker recordings
Export	Standard report layout when exporting the report to a hospital information system
Export PM	Standard report layout for pacemaker recordings when exporting the report to a hospital information system
Export event re-corder	Export of event episodes imported from an event re-corder
Event Recorder	Standard report layout for event recordings
Long recordings	Standard report layout for recordings of more than 48 hours
Long recordings PM	Standard report layout for pacemaker recordings of more than 48 hours
Export long recordings	Standard report layout when exporting the report of recordings of more than 48 hours to a hospital information system
Export long recordings PM	Standard report layout when exporting the report of pacemaker recordings of more than 48 hours to a hospital information system

NOTE:

The report templates supplied with CardioDay V2.5 for the software-generated summary of the report have been thoroughly validated. When inserting or changing variables in a report template, take special care in verifying the correct display of those values.

For customizing the report templates, they are selected in the **Report** menu and opened with Microsoft WordPad. You can also open the file in Microsoft Word in order to use tables, which makes it easier to align the content.

The Setup menu



Example of an RTF template file

All files contain descriptive text (e.g., Number of QRS complexes;) and a \$-variable with optional control characters (e.g., \$QRS_NO:6). During printout, the variables are replaced by their corresponding actual value.

Up to two figures separated by a colon can be added to the variable as format instructions. This allows you to specify the minimum number of print characters to be used in printing and the number of digits after the decimal point.

In any of the files, you can change the descriptive texts and use the \$-variables as required to specify and arrange the contents of the tables.

The example

Number of QRS complexes: \$QRS_NO:6

would be presented in the report as

Number of QRS complexes: 123456

if the real number of recognized QRS complexes was 123,456.

Save the template file when it suits your needs.

You can save the customized template under another name as an RTF file. The template saved will be displayed in the dropdown list in the upper right part of the **Report** tab. You have to switch between tabs once before you can select the new template from the dropdown list.

NOTE:

Additionally, you can program the templates as described in “[Setup > Report > Advanced > Narrative report](#)” on page 240.

Setup > Report > Advanced...

The **Advanced** sub-menu comprises tools to assist you in entering your **Diagnosis**. The sub-menu has options to insert **Text modules** or to activate **Word and phrase auto-completion**.

Also, you can include a narrative report section through the use of the **Script Programming** function.

Text modules button next to the Diagnosis part of the Report

Setup > Report > Advanced > Text modules

To define your own customized text modules, use the **Text modules** menu.

If you select the **Setup > Report > Advanced...** menu, a window for your entries opens.

Setup > Report > Advanced > Text modules

To define a new module, first define an appropriate abbreviation or mnemonic, then use the **Tab** key to exit the field.

The program automatically assigns a hotkey combination to this text module and places the cursor in the editor section of the form, allowing you to enter the actual text.

The Setup menu

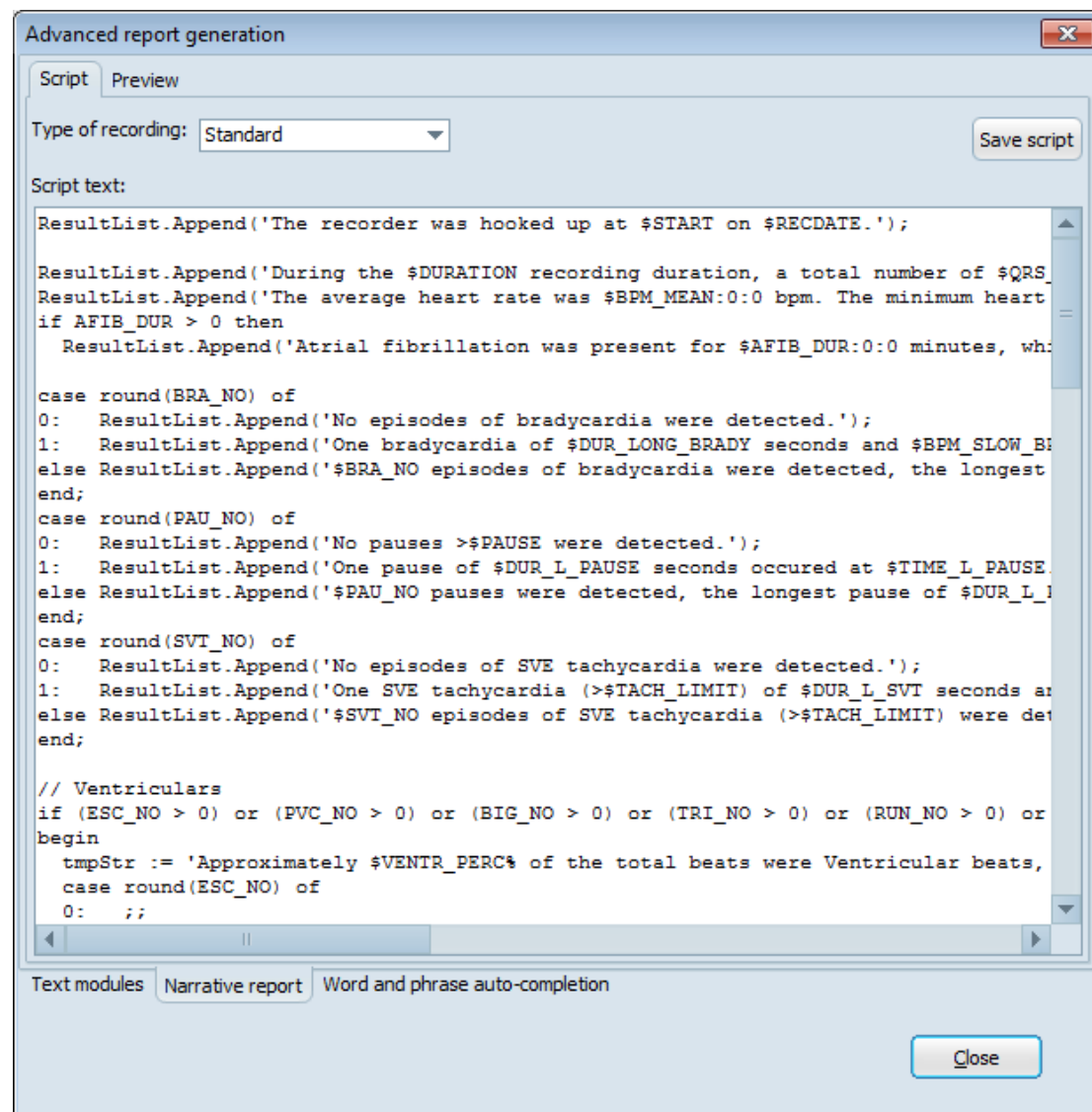
- To complete, store the text entered by clicking ✓.
- To enter a new text module, click the “+” icon.
- To remove a module, click the “-” icon.

Setup > Report > Advanced > Narrative report

NOTE:

For this option, you need experience in script programming.

The results of your script are not included in the software-generated summary of the report until you enter the \$NARRATIVE variable into the respective template.



Setup > Report > Advanced > Narrative report

Script programming allows you to generate formulated text for the software-generated summary of the report. To do so, you insert variables into the **Script text** portion of the window. This programs the template to display certain information dependent upon the

outcome of programmed conditions. For a list of the variables you can insert, see the appendix of this manual.

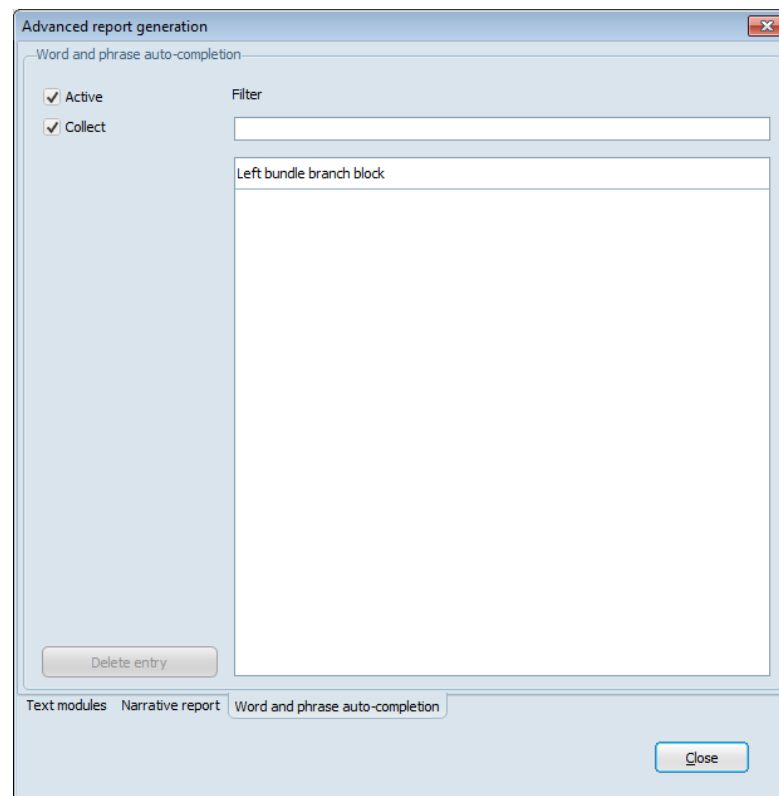
Select the **Type of recording**.

On the **Script** sub-tab, you program your report.

On the **Preview** sub-tab, you can evaluate the print result and the text generated using the variables.

Setup > Report > Advanced > Word- and phrase auto-completion

If your reports contain recurring text, it is practical to use **Word and phrase auto-completion**.



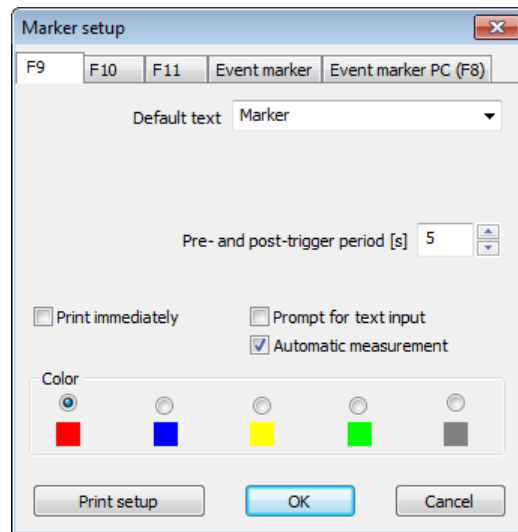
Setup > Report > Advanced > Word- and phrase auto-completion

If you select the **Activate** or **Collect** options, the software stores the entered text and automatically inserts it the next time you start to type the text in a report.

The inserted text will disappear as soon as you type a character that does not match the stored text.

Setup > 12-channel markers...

You can set the parameters for the 12-channel markers in this dialog:



12-channel marker setup

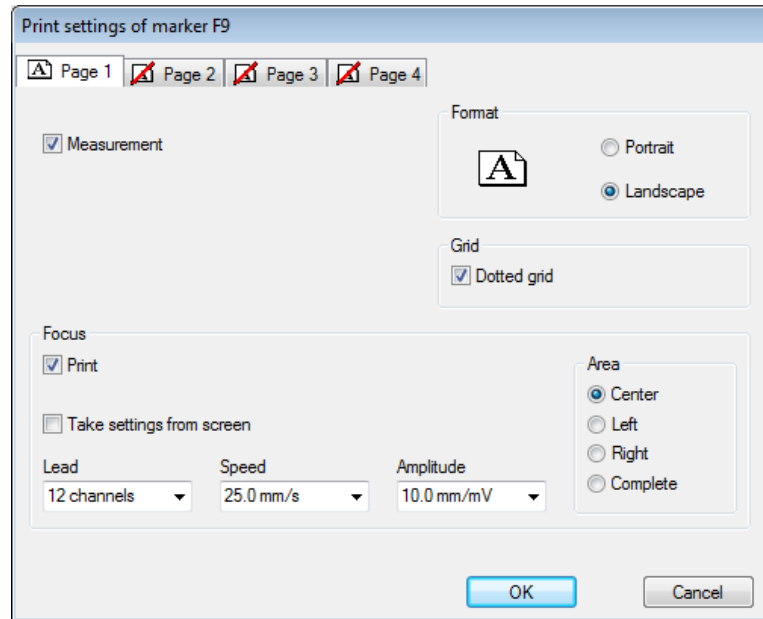
Marker setup:

- a **Default text** to name this specific marker
- **Pre- and post-trigger period**

You can also select:

- **Print immediately**,
- **Automatic measurement**,
- **Color**, and
- **Prompt for text input**.

By left-clicking the **Print setup** button, you open a dialog in which you can set printing options for each page separately.



Marker setup, Print settings for 12-channel markers

Setup > Printer...

This menu item opens the normal Windows printer selection window, where you can select a printer for CardioDay other than the default Windows printer.

Setup > Rebuild list of recordings

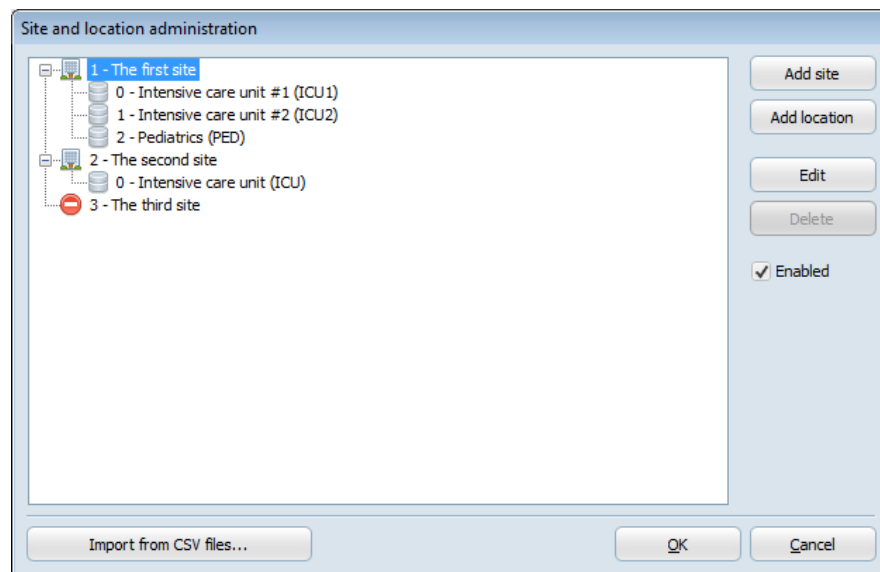
It is only necessary to create a new list of existing recordings if the contents of the recordings' subfolders have been changed manually. Normally, it is not necessary to use this menu command.

This procedure may take several minutes to complete, depending on the number of recordings and the speed of the computer/network.

Setup > Site and location administration...

The **Site and location administration** window allows the administrator to manage different sites and locations within CardioDay.

You can set up to 254 different sites and 65535 locations per site. The location setup limit is 254,000 locations.



Link and add correct title

Add site

1. At the **Site and location administration** window, click the **Add site** button.

The **Add site** window opens.

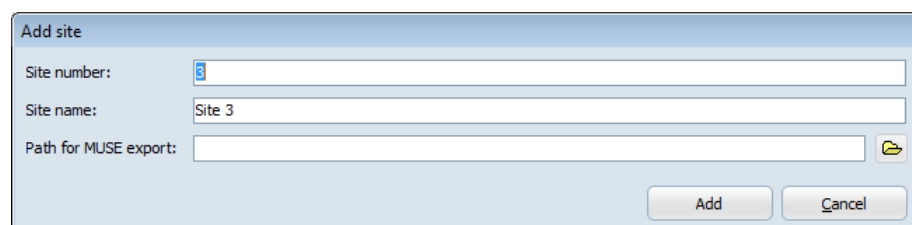
2. Enter the **Site number** (1 to 254) and **Site name**.
3. If you are sending the report to a MUSE system, you can enter the **Path for MUSE export** to set the location of the report when using the **Export** button.

NOTE:

If you enter the **Path for MUSE export** here, the **Path for MUSE export** set in the [Setup > File path...](#) menu will not be used.

4. Click the folder symbol to add the path.

If no export path is entered, a default export path is used. See ["Setup > Other options > MUSE connection"](#) on page 234.



Add site

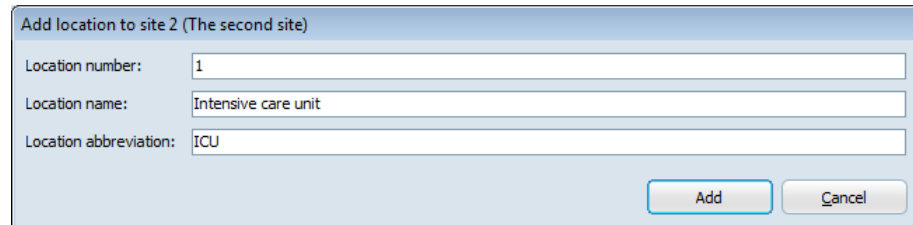
5. Click the **Add** button.

The site will now be displayed in the **Site and location administration** window.

Add a location

1. Highlight the Site in the **Site and location administration** window to which you want to add a location to.
2. Click the **Add location** button.

The **Add location** window opens.



Add location

3. Enter the **Location number** (0 to 65534), **Location name** and the **Location abbreviation**.
4. Click the **Add** button.

The location will now be displayed in the **Site and location administration** window under the selected site.

Editing a Site or Location

You can edit a site or location by selecting the corresponding site or location and pressing the **Edit** button. The **Edit site** or **Edit location** window will open and you can edit the **Number**, **Name**, **Path for MUSE export**, or **Location abbreviation**.

Disabling a site or deleting a location

Sites can be disabled and locations deleted.

If a site should be disabled, proceed as follows:

1. Select the site.
2. Remove the checkmark from the checkbox **Enabled**.



The site will still be visible in the list but shows a red symbol that indicates that this site is no longer enabled. Disabled sites can no longer be assigned to any user and cannot be seen by any user.

If a location should be disabled, proceed as follows:

1. Select the location
2. Click the **Delete** button.

The location will now be removed from the list. It will no longer be visible in the **Site and location administration** window and the location can no longer be assigned to a user.

If a site/location is assigned to a user who has no other site / location assigned, the disable/delete functionality will not be active. An error message will explain that this operation is not possible.

NOTE:

Disabling sites or deleting locations will hide recordings assigned to the site or location for users that do not enable **No site/location filtering** as explained in [“Site and Location management for users and groups”](#) on page 253.

Importing Sites and Locations from MUSE

Sites and locations can be set up identically in the MUSE System and CardioDay by importing CSV files containing site and location information from the MUSE system.

1. Click the **Import from CSV files...** button.
A file browsing dialog opens.
2. Select the CSV file that contains the site information and click **Import**.

NOTE:

It is assumed that for each site that is defined in the sites CSV file, a CSV file containing the locations for this site is located in the same folder. The location CSV files should be named `MuseLocationData_Site<SITENUMBER>.CSV`.

Setup > User administration...

NOTE:

The **User administration** menu is only accessible if you are logged into CardioDay as administrator.

In the **User administration** dialog, you can create and delete user and group accounts, assign user rights to existing accounts and change the password for local user accounts. Sites and locations can be assigned to a user or to a user group.

Overview

With local CardioDay user accounts and CardioDay user group accounts, two kinds of user accounts can be distinguished in CardioDay. Both types only differ in the mechanism used to grant a set of CardioDay user rights.

- Local CardioDay user accounts
The local user accounts are stored and managed by CardioDay in the CardioDay database independently of the Windows user accounts. Each user account has to be created by a CardioDay administrator manually.

A user can log on to CardioDay using the user name and password of a particular local CardioDay user account.

- CardioDay user group accounts – Single Sign-on (SSO)

The user group accounts are also stored and managed by CardioDay in the CardioDay database but are related to Windows groups defined on the Active Directory Server(s) that is/are managing the Windows Domain(s) of the Windows user accounts running CardioDay.

For logon via a user group account, a user is identified on CardioDay by using his Windows user name and password (SSO).

CardioDay uses the names of the Active Directory groups of this Windows user account to associate it with a CardioDay user group account. One of the users Active Directory group names has to correspond with the pattern of the CardioDay user group account. Local Windows groups are not evaluated.

A configured local CardioDay user account or a CardioDay group account can be marked with the **Auto logon** flag in the CardioDay user administration.

If this flag is set, CardioDay does not prompt for user name and password once one of the following conditions is true:

- The Windows user name of the user that is running CardioDay matches with the user name of a local CardioDay account.

NOTE:

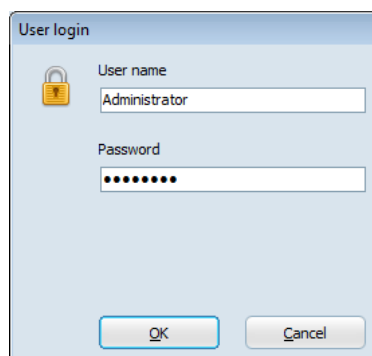
This feature is activated only if the workstation that is running this CardioDay instance is not joined in a Windows Domain.

- The Windows user account running CardioDay can be authenticated via a CardioDay user group account.

If none of these conditions apply, the user has to enter user name and password when starting CardioDay.

User administration for a new installation

By default, you will be prompted for **User name** and **Password** when CardioDay starts:



User login

On a new installation, type the following to log on as Administrator:

User name: **Administrator**

Password: **14012013**

NOTE:

The **Administrator** user name is localized. Depending on the system's local settings, you may have to type a different name, e.g., **Administratör** for Swedish, **Administrateur** for French, etc.

CardioDay allows you to automatically log on local users or domain groups (Single Sign-On) and to assign specific user rights to them.

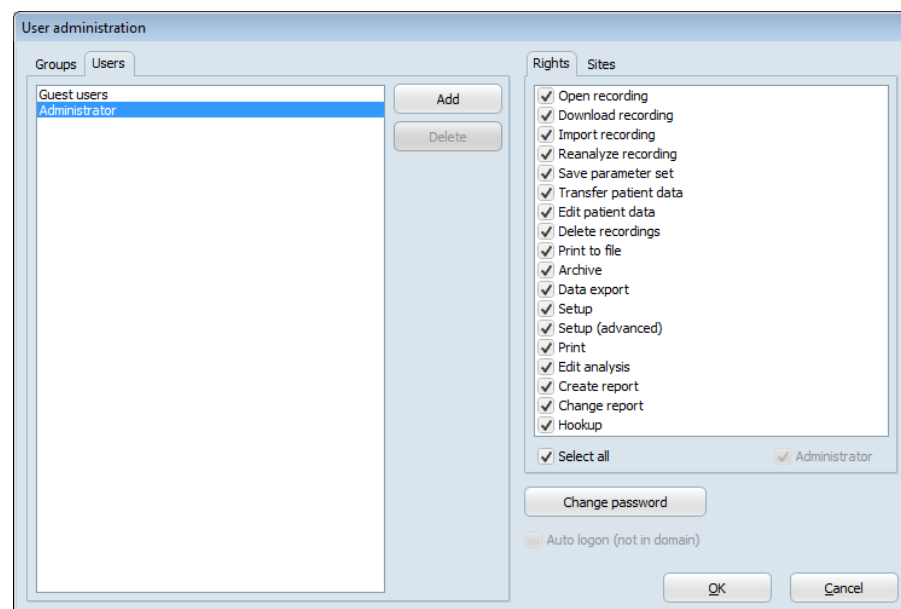
Two user profiles are predefined and cannot be deleted:

- The **Administrator** profile has all user rights including user administration.
- The **Guest users** profile has, by default, no rights assigned. This profile is applied if the **User logon** window is skipped by clicking the **Cancel** button.

Adding a new user account

To add a user account to CardioDay, proceed as follows:

1. Log in as **Administrator**.
2. Select **Setup > User administration...** to open the **User administration** window.



User administration window

3. Click **New user**.

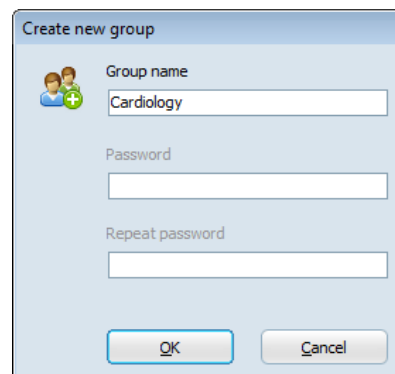
Create new user window

4. Enter a **User name**.
The User name is not case sensitive.
 5. Enter a **Password** with at least 8 characters. Repeat the password in the **Repeat password** field.
The password is case sensitive.
This password must be entered in the **User logon** window under the following conditions:
 - CardioDay is launched and the **Auto Logon** option is disabled (see step 8).
 - The **Setup > Change user...** menu is selected to switch the current CardioDay user.
 6. Click **OK** to close the **New user** window and return to the **User administration** window.
 7. Select the user rights for the new user or check **Select all** to grant all user rights. Refer to "[Selectable user rights](#)" on page 251 for details.
 8. Check **Auto Logon** to skip the **User logon** window when the user launches CardioDay.
- NOTE:**
The **Auto Logon** feature for users is disabled on domain computers.
9. Check **Administrator** if you want to grant additional user creation/administration rights to a user.
 10. If required, repeat steps 3 through 9 to configure additional users.
 11. After you have configured all the new users, click **OK** to activate the changes.

Adding a new group account (for domain computers only)

To add a domain group to CardioDay, proceed as follows:

1. Log in as **Administrator**.
2. Select **Setup > User administration...** to open the **User administration** window.
3. Click **New group**.



Create new group

4. Enter a **Group name**.

The group name is not case sensitive and must correspond to an Active Directory group name.

NOTE:

If multiple domains are present in the network and group members from other domains need to use CardioDay, prepend the domain name followed by a backslash, e.g., "Domain2\Group1".

5. Click **OK** to close the **Create new group** window and return to the **User administration** window.
6. Select the rights for the group members or check **Select all** to grant all rights. Refer to "[Selectable user rights](#)" on page 251 for details.
7. Check **Auto Logon** to skip the **User logon** window when group members launch CardioDay.

NOTE:

If **Auto Logon** is unchecked, group members must enter their Windows user name and password in the **User logon** window when CardioDay is launched.

8. Check **Administrator** to grant the additional user administration permission to the group members, if applicable.
9. If required, repeat steps 3 through 9 to configure additional domain groups.

10. After you have configured all the new domain groups, click **OK** to activate the changes.

Guest user rights on failed or canceled authentication

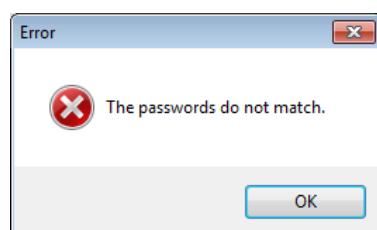
If the user cannot provide valid user credentials and cancels the login procedure, CardioDay will grant the access to CardioDay on a minimum user right level, depending on the **Guest users** configuration.

The CardioDay administrator can change the minimum user rights level by configuring the rights of the CardioDay **Guest users**.

Changing the default administrator password after installation

NOTE:

Systems and recorders with mismatched protection keys will be restricted from communicating and will not be able to transfer patient/study information.



Error message when passwords do not match

For security reasons, it is highly recommended that the default password of the CardioDay administrator be changed.

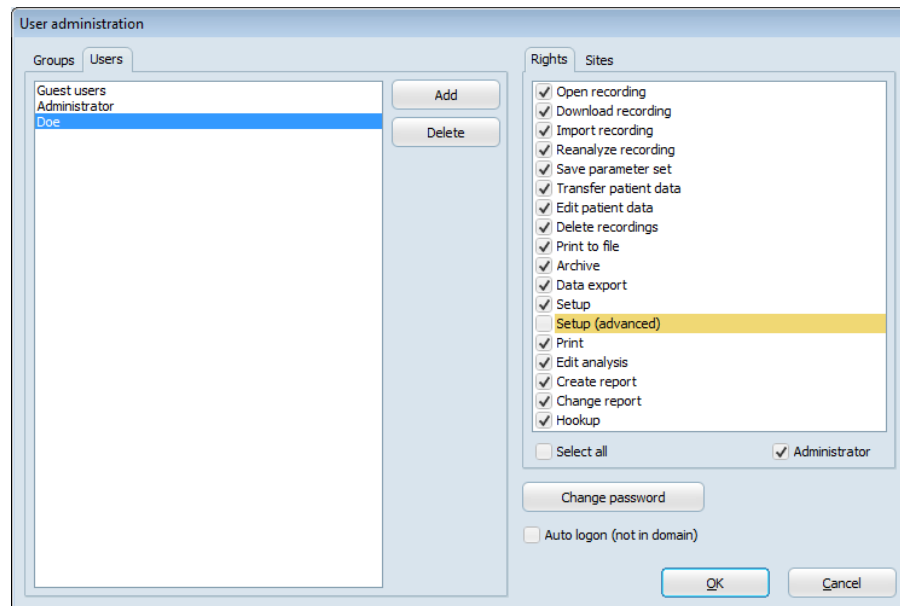
If the SEER 1000 App is used in combination with CardioDay, please make sure to use the same administrator password in both CardioDay and the SEER 1000 App. The configured administrator password will be stored on the recorder as a protection key when patient data is transferred to it.

Selectable user rights

To assign user rights to a CardioDay user or group, you have to be logged in as an administrator. In CardioDay, each local CardioDay user and CardioDay group account can be associated with a set of user rights.

Check the user right in the list to allocate this right to the user or user group currently marked.

The Setup menu



User administration > Assigning user rights

The following user rights are available:

Permission	Enables
Open recording	Recording > Open... menu, Open toolbar button
Download recording	Recorder > Download recording , Recorder > Download long recording , Recorder > Download event recording menus, Download toolbar button, Download recording , Download long recording buttons on the Start window
Import recording	Recording > Import... , Recording > Monitoring acquisition... menus
Reanalyze recording	Recording > Reanalyze... menu (only enabled for the currently opened recording. If the user/group has additional Administrator right, the menu is always enabled)
Save parameter set	Save as default button in the "Signal evaluation and analysis parameters" window
Transfer patient data	Recorder > Transfer patient data... menu, Pat. Data toolbar button
Edit patient data	All fields on the window opened with the Recording > Patient data menu
Delete recordings	Recording > Delete... menu
Print to file	Export > Print to file... menu
Archive	Entire Archive menu

Permission	Enables
Data export	<i>Export > HRV data export...</i> , <i>Export > MIT export...</i> , <i>Export > CSV export</i> , <i>Export > XML export</i> menus (MIT / CSV / XML exports must be manually configured in cardioday.ini)
Setup	<i>Setup > Screen > Colors</i> , <i>Setup > RR-FFT...</i> , <i>Setup > Rebuild list of recordings</i> menus <i>Setup > Other options...</i> menu (<i>Miscellaneous</i> tab only) <i>Classes > Context menu > Colors</i> <i>Classes > Channel selection > Save as default</i>
Setup (advanced)	<i>Setup > Screen > Scale</i> , <i>Setup > File paths...</i> , <i>Setup > Report</i> , <i>Setup > 12 channel markers...</i> menus <i>Setup > Other options...</i> menu (all tabs, Setup permission must be enabled as well, Archive permission must be enabled to show the <i>Archive</i> tab) <i>Report > Select template</i> <i>Print > Store template, Delete template</i>
Print	<i>PDF</i> and <i>Print</i> buttons on the <i>Print</i> tab
Edit analysis	Editing in the <i>Classes</i> and <i>Events</i> tab, <i>Extras > Create 12 channel markers...</i> menu for 12 channel recordings
Create report	Editing in the <i>Report</i> tab
Change report	<i>Diagnosed</i> checkbox on the <i>Report</i> tab
Hookup	<i>Recorder > Hookup...</i> menu, <i>Hookup</i> toolbar button, <i>Hookup</i> button on the <i>Start</i> window
Administrator	<i>Setup > User administration</i> menu

This list of user rights is predefined and cannot be changed.

Site and Location management for users and groups

NOTE:

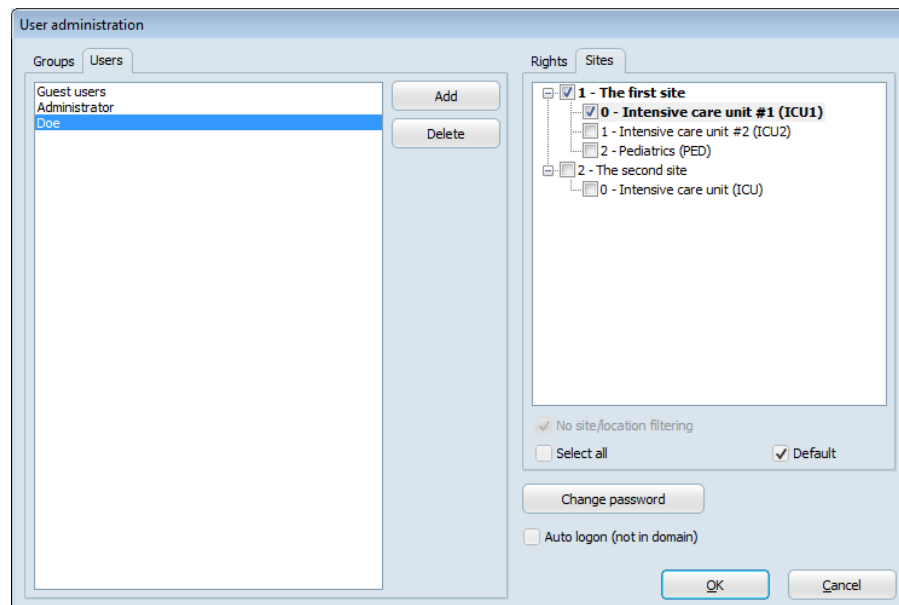
To assign a site and location to a CardioDay user or group, administrator rights are needed.

In CardioDay, each local CardioDay user and CardioDay group account can be associated with selected sites and locations. For further details, refer to “[Setup > Site and location administration...](#)” on page 243.

If a user is assigned to certain sites and locations, this user will only be able to see recordings in the recording list or archive and restore recording data matching these specific sites and locations.

To assign a site and location to a user or group perform the following steps:

1. On the **Users** tab, select the user or group.
2. On the **Sites** tab, select the site and corresponding location to assign this site/location to the user or group selected on the **Users** tab.



User administration

The first site and location selected for a certain user is automatically set as the default.

3. To change the default selection, select another site and location and select **Default**.
4. Select **Select all** to assign all of the sites and locations to the user or group.
5. Select **No site/location filtering** to enable the user access to all recordings on all sites and locations.

NOTE:

During an upgrade installation from a previous CardioDay version, the **No site/location filtering** option is automatically enabled for all existing users.

Setup > Change user

The **Change user** option allows a different user to log on to CardioDay. When you change users, the CardioDay login window opens, and the user must enter a valid CardioDay user name and password.

NOTE:

The **Change user** action will log out the current user and close any recordings that may be open at the time of logout. Any unsaved changes in the open recording will be saved.

27

The Help menu

The **Help** menu displays the contents of the operator manual.

Help > Contents

This option helps to quickly find an answer in the online operator's manual.

Help > Quick start guide

This option helps to quickly find an answer in the online quick start guide.

Help > About

This sub-menu lists the CardioDay program version, the serial number, the UDI (Unique Device Identification), and the Host ID, as well as the copyright notice.

Help > Version

This sub-menu lists the software versions of all the executable (EXE) programs and DLL files (Dynamic Link Libraries) used in conjunction with CardioDay.

This window also displays the following:

- The configured program and data directory paths
- The software key serial number
- The characteristics of your computer's hard drives
- The maximum number of concurrent users
- The Host ID, which is required for licensing

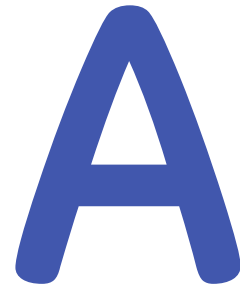
Help > Options

This sub-menu lists all the available optional features of CardioDay. The ones that are marked with an X are activated in your CardioDay. Note that not all the listed options might be available for purchase in your region.

Part III

—

Appendices



Variables for customizing the report templates

NOTE:

The report templates supplied with CardioDay V2.5 for the software-generated summary of the report have been thoroughly validated. When inserting or changing variables in a report template, take special care in verifying the correct display of those values.

For the necessary information, refer to [“Customizing and saving report templates”](#) on page 236.

The variables are grouped as follows:

- [“Patient data”](#), page 260
- [“General data”](#), page 260
- [“Analysis parameters”](#), page 261
- [“Pacemaker-related analysis parameters”](#), page 261
- [“Event data and measured values”](#), page 262
- [“Heart rate variability parameters”](#), page 266
- [“Heart Rate Turbulence and Deceleration capacity”](#), page 267
- [“Combined variables”](#), page 267
- [“Pacemaker data”](#), page 269
- [“Information on the recording”](#), page 269
- [“Information on recordings from an event recorder”](#), page 270

Patient data

Variable	Meaning
\$NAME	Patient's surname
\$FORENAME	Patient's first name
\$AGE	Patient's age
\$ADDRESS	Patient's address
\$BIRTH_DATE	Patient's date of birth
\$GENDER	Patient's sex
\$ID	Patient's ID as entered in recorder
\$PHONE	Patient's telephone number
\$REFERRED_BY	Referring doctor
\$PROCESSED_BY	Operator
\$TECHNICIAN_ID	Technician (Patient data window)
\$INSURANCE	Patient's medical insurance company
\$INSURANCE_NO	Patient's insurance number
\$INDICATION	Indication of referring doctor
\$MEDICATION	Medication prescribed by referring doctor
\$COMMENTS	Comments of the evaluator
\$VISIT_ID	Visit ID
\$ORDER_NUMBER	Order number from MUSE or HL7

General data

Variable	Meaning
\$EVDATE	Date of evaluation (date only)
\$RECDATE	Date of recording
\$EVDATE_W	Date of evaluation (including day of the week)
\$DURATION	Duration of recording
\$START	Time recording commenced
\$USERNAME	Name of the user name currently logged-in in CardioDay
\$CARDIODAYOPTION	Option code in the SSA license file
\$TOC	Report contents
\$DIAGNOSED_BY	Name of the CardioDay user who sets the status of the recording to "diagnosed", actualization at every change
\$CREATED_BY	Name of the CardioDay user who has downloaded the recording or has reanalyzed it

Analysis parameters

Variable	Meaning
\$PARAM_SET	Parameter set used for analysis
\$BRAD_LIMIT	Threshold value for bradycardia detection
\$SENSE1	(Download) amplification channel 1
\$SENSE2	(Download) amplification channel 2
\$VTACH_LIMIT	Threshold value for VE tachycardia detection
\$SVTACH_LIMIT	Threshold value for SVE tachycardia detection
\$SVT_MIN_BEATS	Minimum beat count for SVE tachycardia
\$PRE_SV	Percentage above which an SV is considered premature
\$PRE_V	Percentage above which a PVC is considered premature
\$PAUSE	Minimum duration of pauses (anything below this value is an arrhythmia)
\$QRS_DIFF	Type of QRS form differentiation
\$R_ON_T	Threshold for R-on-T detection (max. interval, no searches beyond this value)
\$DELAY_QRS	Percentage of the current to average RR interval, above which a QRS complex is considered delayed
\$ST_CH1	Channel number of the first ST analysis channel
\$ST_CH2	Channel number of the second ST analysis channel
\$CH1_LEAD	Designation of the 12-channel lead displayed in the first channel
\$CH2_LEAD	Designation of the 12-channel lead displayed in the second channel
\$CH3_LEAD	Designation of the 12-channel lead displayed in the third channel
\$CH4_LEAD	Designation of the 12-channel lead displayed in the fourth channel

Pacemaker-related analysis parameters

Variable	Meaning
\$PM_HYST	Pacemaker hysteresis
\$PM_MODE	Pacemaker type
\$PM_RATE	Basic rate of pacemaker

Event data and measured values

Variable	Meaning
\$QRS_NO	Total number of all detected QRS complexes
\$BEAT_N_COUNT	Total number of N beats
\$BEAT_N_PERCENT	Percentage of N beats
\$BEAT_N_MAX_HOUR_COUNT	Max. hourly count of N beats
\$BEAT_N_MAX_HOUR_TIME	The hour of the max. count of N beats
\$BEAT_V_COUNT	Total number of V beats
\$BEAT_V_PERCENT	Percentage of V beats
\$BEAT_V_MAX_HOUR_COUNT	Max. hourly count of V beats
\$BEAT_V_MAX_HOUR_TIME	The hour of the max. count of V beats
\$BEAT_X_COUNT	Total number of X beats
\$BEAT_X_PERCENT	Percentage of X beats
\$BEAT_X_MAX_HOUR_COUNT	Max. hourly count of X beats
\$BEAT_X_MAX_HOUR_TIME	The hour of the max. count of X beats
\$BEAT_P_COUNT	Total number of P beats
\$BEAT_P_PERCENT	Percentage of P beats
\$BEAT_P_MAX_HOUR_COUNT	Max. hourly count of P beats
\$BEAT_P_MAX_HOUR_TIME	The hour of the max. count of P beats
\$PVC_PERC	Percentage of PVC
\$SVE_PERC	Percentage of SVE
\$BEATS_ALL_V_EVT	Total count of beats in ventricular events
\$BEAT_PERC_ALL_V_EVT	Total percentage of beats in ventricular events
\$BEATS_ALL_SV_EVT	Total count of beats in supraventricular events
\$BEAT_PERC_ALL_SV_EVT	Total percentage of beats in supraventricular events
\$PQR_NO	Total count of paced beats
\$PQR_PERC	Total percentage of paced beats
\$AQRS_PERC	PM analysis: percentage of atrial stimulation with own transition
\$VQRS_PERC	PM analysis: percentage share of ventricular stimulation with subsequent QRS complex
\$BPM_MEAN	Mean heart rate (HR)
\$BPM_MAX	Maximum HR, calculated over 1 minute
\$BPM_MAX_TIME	Time of maximum HR
\$BPM_MAX_MAX	Maximum short-time HR
\$BPM_MAX_MAX_TIME	Time of Max. short-time HR

Variable	Meaning
\$BPM_MIN	Minimum HR, calculated over 1 minute
\$BPM_MIN_TIME	Time of minimum HR
\$BPM_MIN_MIN	Minimum short-time HR
\$BPM_MIN_MIN_TIME	Time of minimum short-time HR
\$DUR_RR_MIN	Duration of shortest RR interval
\$TIME_RR_MIN	Time of shortest RR interval
\$DUR_RR_MAX	Duration of longest RR interval
\$TIME_RR_MAX	Time of longest RR interval
\$BEATS_ALL_BRADY	Count of beats in bradycardia
\$BEAT_PERC_ALL_BRADY	Percentage of beats in bradycardia in relation to the total number of QRS complexes
\$DUR_ALL_BRADY	Duration of all bradycardia
\$DUR_PERC_ALL_BRADY	Percentage of duration of all bradycardia
\$BEATS_SLOW_BRADY	Count of beats in the slowest bradycardia
\$BPM_SLOW_BRADY	HR in the slowest bradycardia episode
\$TIME_SLOW_BRADY	Time of slowest bradycardia episode
\$DUR_SLOW_BRADY	Duration of the slowest bradycardia episode
\$BEATS_LONG_BRADY	Count of beats in the longest bradycardia
\$BPM_LONG_BRADY	HR in the longest bradycardia episode
\$DUR_LONG_BRADY	Duration of the longest bradycardia episode
\$TIME_LONG_BRADY	Time of longest bradycardia episode
\$DUR_L_DEL	Duration of longest N-N delay
\$TIME_L_DEL	Time of longest N-N delay
\$DUR_L_PAUSE	Duration of longest pause
\$TIME_L_PAUSE	Time of longest pause
\$BEATS_ALL_VT	Count of beats in VE tachycardia
\$BEAT_PERC_ALL_VT	Percentage of beats in VE tachycardia in relation to the total number of QRS complexes
\$DUR_ALL_VT	Duration of all VE tachycardia
\$DUR_PERC_ALL_VT	Percentage of duration of all VE tachycardia
\$BEATS_L_VT	Count of beats in the longest VE tachycardia
\$BPM_L_VT	HR in the longest VE tachycardia episode
\$DUR_L_VT	Duration of longest VE tachycardia episode
\$TIME_L_VT	Time of longest VE tachycardia episode
\$BEATS_FAST_VT	Count of beats in the fastest VE tachycardia
\$DUR_FAST_VT	Duration of the fastest VE tachycardia episode
\$BPM_FAST_VT	HR in fastest tachycardia episode

Variables for customizing the report templates

Variable	Meaning
\$TIME_FAST_VT	Time of fastest tachycardia episode
\$BEATS_ALL_SVT	Count of beats in SVE tachycardia
\$BEAT_PERC_ALL_SVT	Percentage of beats in SVE tachycardia in relation to the total number of QRS complexes
\$DUR_ALL_SVT	Duration of all SVE tachycardia
\$DUR_PERC_ALL_SVT	Percentage of duration of all SVE tachycardia
\$BEATS_L_SVT	Count of beats in the longest SVE tachycardia
\$BPM_L_SVT	HR in the longest SVE tachycardia episode
\$DUR_L_SVT	Duration of longest SVE tachycardia episode
\$TIME_L_SVT	Time of longest SVE tachycardia episode
\$BEATS_FAST_SVT	Count of beats in the fastest SVE tachycardia
\$DUR_FAST_SVT	Duration of the fastest SVE tachycardia episode
\$BPM_FAST_SVT	HR in fastest SVE tachycardia episode
\$TIME_FAST_SVT	Time of fastest SVE tachycardia episode
\$SVT_GE4_NO	Total count of supraventricular tachycardia episodes (count $\geq$ 4 beats)
\$BEATS_ALL_SVT_GE4	Total count of beats in supraventricular tachycardia episodes (count $\geq$ 4 beats)
\$BEAT_PERC_ALL_SVT_GE4	Total percentage of beats in supraventricular tachycardia episodes (count $\geq$ 4 beats)
\$DUR_ALL_SVT_GE4	Total duration of supraventricular tachycardia episodes (count $\geq$ 4 beats)
\$DUR_PERC_ALL_SVT_GE4	Total percentage of duration of supraventricular tachycardia episodes (count $\geq$ 4 beats)
\$BEATS_L_SVT_GE4	Count of beats in longest supraventricular tachycardia episode (count $\geq$ 4 beats)
\$BPM_L_SVT_GE4	Heart rate of longest supraventricular tachycardia episode (count $\geq$ 4 beats)
\$TIME_L_SVT_GE4	Time of longest supraventricular tachycardia episode (count $\geq$ 4 beats)
\$DUR_L_SVT_GE4	Duration of longest supraventricular tachycardia episode (count $\geq$ 4 beats)
\$BEATS_FAST_SVT_GE4	Count of beats in fastest supraventricular tachycardia episode (count $\geq$ 4 beats)
\$BPM_FAST_SVT_GE4	Heart rate of fastest supraventricular tachycardia episode (count $\geq$ 4 beats)
\$TIME_FAST_SVT_GE4	Time of fastest supraventricular tachycardia episode (count $\geq$ 4 beats)
\$DUR_FAST_SVT_GE4	Duration of fastest supraventricular tachycardia episode (count $\geq$ 4 beats)
\$BEATS_ALL_RUN	Count of beats in VE runs

Variables for customizing the report templates

Variable	Meaning
\$BEAT_PERC_ALL_RUN	Percentage of beats in VE runs in relation to the total number of QRS complexes
\$BPM_FAST_RUN	HR in the minute with the fastest VE run
\$TIME_FAST_RUN	Time of fastest salvo VE run
\$BEATS_ALL_TRI	Count of beats in VE triplets
\$BEAT_PERC_ALL_TRI	Percentage of beats in VE triplets
\$SVTRIP_NO	Number of SVE Triplets
\$BEATS_ALL_COU	Count of beats in VE couplets
\$BEAT_PERC_ALL_COU	Percentage of beats in VE couplets in relation to the total number of QRS complexes
\$SVCOUPL_NO	Number of SVE Couplets
\$BEATS_ALL_BIG	Count of beats in VE bigeminy
\$BEAT_PERC_ALL_BIG	Percentage of beats in VE bigeminy in relation to the total number of QRS complexes
\$DUR_ALL_BIG	Duration of all VE bigeminy
\$DUR_PERC_ALL_BIG	Percentage of duration of all VE bigeminy
\$BEATS_L_BIG	Count of beats in the longest VE bigeminy
\$SVE_ISO_NO	Number of isolated SVEs
\$STA_MEAN	Mean ST level
\$STA1_MEAN	Mean ST level, first analysis channel
\$STA2_MEAN	Mean ST level, second analysis channel
\$STA_MAX	Maximum ST level
\$STA_MAX_TIME	Time of maximum ST level per minute
\$STA1_MAX	Maximum ST level, first analysis channel (maximum ST deviation, first analysis channel)
\$STA1_MAX_TIME	Time of maximum ST level, first analysis channel (corresponding time)
\$STA2_MAX	Maximum ST level, second analysis channel
\$STA2_MAX_TIME	Time of maximum ST level, second analysis channel
\$STA_MIN	Minimum ST level
\$STA_MIN_TIME	Time of minimum ST level per minute
\$STA1_MIN	Minimum ST level, first analysis channel (minimum ST deviation, first analysis channel)
\$STA1_MIN_TIME	Time of minimum ST level, first analysis channel
\$STA2_MIN	Minimum ST level, second analysis channel
\$STA2_MIN_TIME	Time of minimum ST level, second analysis channel
\$STA_ABS_MAX	Maximum absolute ST level

Variable	Meaning
\$STA_ABS_TIME	Time of maximum absolute ST level
\$STA1_ABS_MAX	Maximum absolute ST level, first analysis channel
\$STA1_ABS_TIME	Time of maximum absolute ST level, first analysis channel
\$STA2_ABS_MAX	Maximum absolute ST level, second analysis channel
\$STA2_ABS_TIME	Time of maximum absolute ST level, second analysis channel
\$STS_MAX	Maximum ST slope
\$STS_MAX_TIME	Time of maximum ST slope per minute
\$STS_MIN	Minimum ST slope
\$STS_MIN_TIME	Time of minimum ST slope per minute
\$STS_MEAN	Mean ST slope
\$AFIB_DUR	Duration of all AFib episodes in minutes
\$AFIB_PERC	Ratio of the duration of all AFib episodes to the complete recording duration
\$AFIB_EPI_CNT	Number of AFib episodes
\$AFIBEPILIST	List of AFib episodes
\$MARKEDEVENTSLIST	List of events selected for printing as shown in the Print line of the Events tab
\$MARKERLIST	List of markers created in 12 channel recordings

Heart rate variability parameters

These parameters are described in more detail in “[The Heart rate variability tab](#)” on page 117.

- The variables with “NN” at the end refer to all intervals between normal beats.
- The variables with “ALL” at the end refer to all intervals.

Variable	Meaning
\$RR_N_NN or \$RR_N_ALL	Number of considered RR intervals
\$RR_DUR_NN or \$RR_DUR_ALL	Total of considered RR intervals in hours
\$RR_MEAN_NN or \$RR_MEAN_ALL	Linear average value of considered RR intervals in ms
\$RR_MEDIAN_NN or \$RR_MEDIAN_ALL	Median of considered RR intervals in milliseconds

Variable	Meaning
\$SDNN_NN or \$SDNN_ALL	Standard deviation of all considered RR intervals in ms
\$SDANN_NN or \$SDANN_ALL	Standard deviation in milliseconds of the average RR interval calculated every five minutes
\$RR_SD_NN or \$RR_SD_ALL	Standard deviation in milliseconds of the average RR interval calculated every five minutes
\$RR_TI_NN or \$RR_TI_ALL	Dimensionless triangular index of Heart rate variability
\$NN50_NN or \$NN50_ALL	Number of RR intervals of which the difference from preceding RR interval was greater than 50 milliseconds
\$PNN50_NN or \$PNN50_ALL	Percentage of RR intervals of which the difference from preceding RR interval was greater than 50 milliseconds
\$RMSSD_NN or \$RMSSD_ALL	Square root of the mean squared differences between consecutive RR intervals in milliseconds
\$SDNN_INDEX_NN or \$SDNN_INDEX_ALL	Mean standard deviation in milliseconds of the standard deviation of all considered RR intervals calculated every five minutes
\$SDSD_NN or \$SDSD_ALL	Standard deviation of the differences of all consecutive considered RR intervals in milliseconds
\$RR_SKEW_NN or \$RR_SKEW_ALL	Skewness
\$RR_KURTOSIS_NN or \$RR_KURTOSIS_ALL	Kurtosis

Heart Rate Turbulence and Deceleration capacity

Variable	Meaning
\$HRT_N	Number of VES used for calculating HRT
\$HRT_TO	HRT Onset
\$HRT_TS	HRT Slope
\$DC_N	Number of Anchor intervals used for calculating the deceleration capacity
\$DC_VAL	Value of the deceleration capacity
\$DC_RISK	Risk as derived from the value of the deceleration capacity
\$AC_N	Number of Anchor intervals used for calculating the acceleration capacity
\$AC_VAL	Value of the acceleration capacity

Combined variables

Many variable names are composed of an abbreviation of the value concerned and a suffix separated by the “_” symbol. Examples of combined variables are shown below.

The suffixes have the following meaning:

Suffix	Meaning
NO	Total number of the events concerned
MAX_NO	Maximum number of the events concerned over one hour
MAX_HOUR	Hour in which this number of events occurred
MIN_NO	Minimum number of the events concerned over one hour
MIN_HOUR	Hour in which this number of events occurred

Events that can be used with these suffixes are abbreviated as follows:

Prefix	Meaning
\$DEL_	N-N Delay episodes
\$SVT_	Supraventricular tachycardias
\$BIG_	VE Bigeminy
\$BRA_	Bradycardia episodes
\$COU_	VE Couplets
\$ESC_	Other ventricular beats
\$PAU_	Pauses
\$R_T_	R-on-T events
\$RUN_	VE Runs
\$NOI_	Noise detected by the program
\$SVE	Supraventricular events
\$TRI_	VE Triplets
\$PVC_	Premature ventricular contraction
\$VTA_	Number of ventricular tachycardias

The following are examples of completely combined variable names and their meaning:

Variable	Meaning
\$DEL_NO	Number of N-N delay episodes
\$SVT_MAX_NO	Max. number of supraventricular tachycardias over one hour
\$BIG_MAX_HOUR	Hour in which most VE bigeminies occurred ¹

Variable	Meaning
\$BRA_MIN_NO	Min. number of bradycardia episodes over one hour
\$COU_MIN_HOUR	Hour in which least number of VE couplets occurred ¹

¹ In the event of several hours with the same maximum and minimum frequency, the first hour will be shown first.

Pacemaker data

Abbreviations of pacemaker events used with suffixes:

Prefix	Meaning
\$APA_	Atrial stimulus
\$AQR_	Atrial stimulus with resonated QRS complex
\$AVP_	AV stimulus
\$EXI_	Exit block episodes
\$FUS_	Fusion beats
\$UND_	Undersensing episode
\$OVE_	Oversensing episode
\$VPA_	Ventricular stimulus
\$VQR_	Ventricular stimulus with resonated QRS complex

Information on the recording

Variable	Meaning
\$ECG_FOLDER	Full path of the ECG directory
\$ECG_FILE_NAME	Name of the ECG raw data file
\$ECG_FILE_DATE	Date of the ECG raw data file
\$ECG_FILE_SIZE	Size of the ECG raw data file
\$RECORDER_TYPE	Model name of the recorder used for the recording
\$RECORDER_SN	Serial number of the recorder used for the recording
\$RECORDING_ID	Unique number automatically assigned by the recorder
\$RECORDING_ID2	Recording number automatically assigned
\$ECG_SAMPLE_RATE	Sampling rate used for the recording in samples per second
\$NO_OF_CHANNELS	Number of the ECG channels stored in the recording
\$NOISE_RANGE_DUR	Total duration of noise regions in hh:mm:ss.
\$NOISE_RANGE_PERC	Percentage of NOISE_RANGE_DUR of the analyzed recording duration

Variables for customizing the report templates

Variable	Meaning
\$ANALYSED_DUR	Overall duration of the regions analyzed in hh:mm:ss
\$ANALYSED_PERC	Percentage of ANALYSED_DUR in the recording duration
\$EVAL_DATE	Date of evaluation
\$EVAL_TIME	Time of evaluation
\$EXPORT_FILENAME	File name used for export of a pdf file
\$SITE_NUMBER	Number of site
\$SITE_NAME	Name of site
\$LOCATION_NUMBER	Number of location
\$LOCATION_NAME	Name of location
\$LOCATION_ABBREVIATION	Abbreviation of location

Information on recordings from an event recorder

Variable	Meaning
\$TMS_TRANSM_TIME	Time of data transmission
\$TMS_PRE_TIME	Pre-event time in seconds
\$TMS_POST_TIME	Post-event time in seconds
\$TMS_BRADY_TRIG	Bradycardia threshold
\$TMS_TACHY_TRIG	Tachycardia threshold
\$TMS_AF_TRIG	Detection of atrial fibrillation
\$TMS_PAUSE_TRIG	Pause in milliseconds
\$TMS_VT_TRIG	VT detection



Definitions

Term	Definition
Active QRS complex	The QRS complex displayed centered in the ECG context display of the Classes and Events tabs is called the active QRS complex. The display is synchronized regularly to the R peak, which is symbolized by a vertical thin blue line through the R peak in the ECG context display.
Analysis channel	The recorder channel used for the analysis. CardioDay uses the best recorded channel.
Analysis parameters	Analysis parameters used to detect events or conditions for events from the sequence of QRS complexes by using thresholds specific to the individual patient group.
Class window	The QRS class windows or bins in the upper part of the workspace on the Classes tab. They display the QRS complexes of the detected QRS classes.
ECG context display	This window displays the context of the current complex. The current complex is displayed in the center. Its R peak is marked with a blue line. The letter over the complexes designate their classification, the numbers between the R-peaks represent either the RR interval milliseconds or its reciprocal value, the heart rate, in beats per minute (bpm). The display can be toggled by double-clicking in it.
ECG episode	Several consecutive QRS complexes with or without clinical significance.
Evaluation	The medical evaluation of the CardioDay analysis results required for the QRS classification and the event classification.

Term	Definition
Event analysis	The event analysis investigates the chronological dependencies of consecutive evaluated QRS complexes using defined rhythm parameters. It detects the cardiological events, subject to medical evaluation.
Event class	Collection of similar events in one class for common editing. The collection criteria, for example, are defined in the analysis parameters.
Event display	The event display shows whether the current QRS complex is part of an already found event.
Event	Cardiologically significant occurrence of one or several atypical or incomplete QRS complexes.
Heart rate display	The heart rate display for the current context. The value is determined either from the moving average of the last 10 QRS complexes or over one minute.
Patient data	All data stored on one recording storage slot for evaluation of the ECG recording.
Patient ID	A unique row of letters and numbers identifying the patient. You can use the ID from the patient management system, if available.
QRS class	Collection of all similar QRS complexes in one class for common editing. Similarity criteria are not limited to optical properties; they are calculated from properties of QRS complexes concerning time and frequency. QRS classes are often simply called "classes".
QRS zoom display	The zoom window displays a magnified image of the current complex. Use the right mouse button to select the magnification and the channel displayed. The number at the bottom left of this window indicates the number of the displayed channel.
Sensitivity	The trigger threshold for QRS recognition can be set to the ECG data being recorded if required.
Signal evaluation	As pre-analysis of the recording, a part of the ECG is read, which is used by the program to check the recording quality and select optimum analysis parameters (which channel, which amplification). This process is called signal evaluation.
Tab	Tabs are used to divide edition options into several partial views of a window. Clicking on a tab activates the corresponding partial view.



System limitations

Event analysis parameter	Setting
Tachycardia threshold SV	30 – 220 bpm
Tachycardia threshold V	30 – 220 bpm
Bradycardia threshold	20 – 100 bpm and less than tachycardia threshold V
Pause	1000 – 9999 ms
Prematurity SV	10 – 99 %
Prematurity V	10 – 120 %
R on T (relative to 1s)	100 – 400 ms
Delayed QRS complex	100 – 200 %
Refractory period	190 – 400 ms
Pacemaker basic rate	40 – 150 bpm
Pacemaker hysteresis rate	20 – 150 bpm
Pacemaker maximum rate	40 – 200 bpm

RR-FFT Frequency Limits	Setting
Lower frequency limit VLF	0 – 0.5 Hz
Lower frequency limit LF	0 – 0.5 Hz
Lower frequency limit HF	0 – 0.5 Hz
Upper frequency limit HF	0 – 0.5 Hz



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