Bradycardia Devices

Merlin™ 2 Patient Care System

Help Manual

For the following devices:
Sustain™
Victory™
Zephyr™

Abbott

Contents

Tools Menu

Contents:

? Button

The ? button opens a window that provides access to the Help manual. You can also access the manual if you select Tools (page 1) > Educational Materials > Help.

Accessed From: Help button

Tools

The Tools menu opens a number of programmer tools, including:

- **PSA**. Opens the PSA application. See the Merlin™ 2 PCS PSA Wand Reference Manual.
- **Session Records**:
  - PDFs. Opens the PDFs window to manage the reports stored as PDFs on the programmer's hard disk.
- **Educational Materials**:
  - **Help**. Opens links for on-line Help for all supported devices.
  - **Demos**. Opens device demonstrations.
- **Maintenance**. Opens utilities for programmer maintenance (for use by Abbott Medical personnel only).
- **Preferences**. Opens the Merlin 2 PCS settings for language, date, format, audio, etc.
- **Customer Support**. Provides contact information for Technical Support (page 69).
- **Print Screen**. Prints an image of the screen.
- **Export Screen**. Exports an image to a USB flash drive.

Accessed From: Tools Button

Session Records

PDFs

Every time you select any Print button to create a report, the Merlin™ 2 PCS programmer saves the report as a PDF (portable document file[1]). This file can be exported to a flash drive connected to one of the programmer's USB ports. You must install Adobe™ Acrobat™ Reader or Adobe Reader™ on your PC to view the PDF[2].

From the PDFs window, you can:

- Check the number of PDFs stored on the programmer's hard disk that have not been exported
- Export Most Recent PDFs (created in the last actual session or demo session, including your current session)
- Delete all PDFs

When you select one of the Export buttons, the Export Data screen appears.

The file naming and storing of the PDFs are as follows:

All PDFs are stored in a folder entitled "PDFs."

Subfolder Name: "Date of PDF creation"

Sub-subfolder Name: "Patient Name_Model Number_Device Serial Number" (read from the Patient Data)
File Name: "Device name_Device Model Number_Device Serial Number_Reportname.pdf"

Example: In the PDF folder is a subfolder called 2008-03-23. In this subfolder is a sub-folder called "John_Smith_5826_201399." Inside the sub-subfolder is the PDF titled Zephyr(TM)-XL-DR_5826_201399_SummaryReport.pdf.

CAUTION: Session Records are not retained.

Accessed From: Tools menu > Session Records > PDFs

Data Export

Data Export applies to data that displays patient information, such as screen captures, data base records, and pdf reports. Data Export is nominally set to encrypt exported data (see Personal Identification Number). Session Records and Programmer Logs are automatically encrypted, and only Abbott Medical personnel can access the data.

You can view Data Export settings in Preferences from the Tools menu To adjust the patient data export setting, contact Technical Support.

Personal Identification Number (PIN). To export data you must create a Personal Identification Number. The PIN cannot:

[1] The programmer does not create a PDF for Freezes printed from the Start-Up screen, the Print Screen function, or on-screen Help.
[2] Adobe, Acrobat, and Adobe Reader are trademarks of Adobe Systems Incorporated.

- Repeat a number six times in succession, for example 555555
- Have consecutive numbers in either ascending or descending order, for example 123456 or 654321

NOTE: Be sure to document the PIN selected. The PIN will be required later to access the data from the flash drive.

Preferences

The Preferences window contains the following tabs for setting the Merlin™ 2 PCS options:

- **Date & Time**. Sets the year, date, and local time
- **Language & Formats**. Sets the:
  - Display and Help Language
  - Date Format
  - Time Format
  - Number Format
  - ECG Notch Filter. The ECG Notch Filter Frequency reduces ECG interference from the programmer's AC power line frequency. Check with your local authorities for your power line frequency.
- **Audio** (page 2)
- **Printer** (page 2)

Accessed From: Tools menu > Preferences button

NOTE: It is important to set an accurate date and time because the device's diagnostic tests and other functions use the date and time from the programmer.

Audio Preferences

This screen contains two panels:

- **General Audio.** Select the On button to allow audio cues for programmer activity. You can also select a volume level. The Off button turns all sounds off (except Charging Audio).
- **Charging Audio** (Tachy devices only). Select the On button for an audio cue when the capacitors charge during a programming session.

NOTE: An audio cue is always emitted during charging for an Emergency Shock, regardless of the Charging Audio setting.

Accessed From: Tools menu > Preferences button > Audio tab

Printer Preferences

Every time you select any Print button to create a report, the Merlin™ 2 PCS programmer saves the report as a PDF (portable document file[3]). This file can be exported to a flash drive connected to one of the programmer's USB ports. You must install Adobe™ Acrobat™ Reader or Adobe Reader™ on your PC to view the PDF.

To view the number of stored PDFs and to export or delete PDFs, select Tools > Session Records > PDFs.

The Printer Preferences window contains two panels:

- **Selected Printer.** You have two choices:
  - PDF Only (Paperless). Sends reports to the programmer's hard disk as a PDF (paperless printing) with no paper documents.
  - External & PDF. Sends the report to an external USB printer and simultaneously creates a PDF on the hard disk. Before reports can be sent to an external printer, you must first connect the external printer to any one of the USB ports on the programmer. For more information on connecting an external printer, see the Merlin 2 PCS User's Manual.
- **Number of Paper Copies.** This selects how many reports are printed by the external printer whenever a Print button is selected.

To view the number of stored PDFs and to export or delete PDFs, select Tools > Session Records > PDFs.

NOTE: **Supported Printers.** The Merlin 2 PCS can print to many laser jet printers. For a list of compatible printers, contact your Abbott Medical Representative or Technical Support (page 69).

Accessed From: Tools menu > Preferences > Printer tab

Print Screen

The Print Screen button prints an image of the current screen.

This function does not create a PDF.

For more information on printing, see Print Menu Settings.

Accessed From: Tools menu > Print Screen button

Export Screen

The Export Screen button opens the Export Data window, which allows you to save the current screen as an electronic (.png) file and send the file to any date storage device (flash drive) connected to one of the programmer's USB ports. The Merlin™ 2 PCS detects all connected devices and asks you to select the device to receive the data.

Accessed From: Tools menu > Export Screen button

[3] The programmer does not create a PDF for Freezes printed from the Start-Up screen, the Print Screen function, or on-screen Help.

Rhythm Display

Contents:

Rhythm Display

The Rhythm Display, seen on the Main Programming Window, can show up to five concurrent waveforms that can be individually configured and adjusted. You can drag and drop any waveform to a new position. You can also freeze the display.

Three types of waveforms can be shown in the Rhythm Display:

- **ECG (electrocardiogram)** (page 3)
- **Markers** (page 3)
- **EGM (intracardiac electrogram)** (page 5)

The controls for the Rhythm Display include the:

– Waveform Control buttons, which are opened from the white labeled buttons on the left side of the display.

– Adjust Display button

– Freeze Capture button

See also:

- Rhythm Display Setup Instructions (page 5)

ECG

The Rhythm Display can show up to five ECG waveforms simultaneously from seven possible ECG vectors. The ECG controls include the:

- **Adjust Display** (page 6) button, which selects the waveform source and configuration
- **Waveform Control** (page 6) buttons, which set the gain and the waveform source

For an example of a typical ECG cable setup, refer to the Merlin™ 2 PCS Model 3700 User's Manual.

See also:

- ECG Configuration (page 6)

Markers

Markers are symbols that represent paced and sensed events, intervals, refractory periods, and algorithm activity. Markers can be viewed as one of the five waveforms. Markers can be configured from the Adjust Display window either as:

- **Basic,** which shows only alphabetical markers appear along a time line (see Figure below)
- **Full,** which adds numeric interval and refractory periods below the basic markers (see Figures below)

For a list of all markers, see the Table of Markers.

The ? marker button opens the help window.

Figure 1. Basic marker configuration

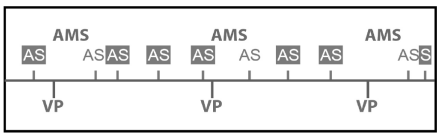


Figure 2. Full marker configuration

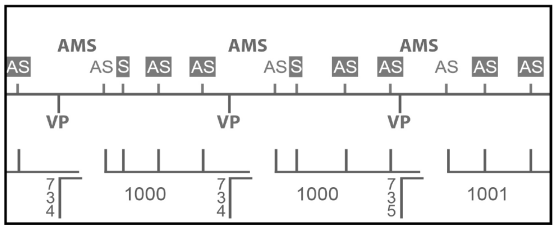
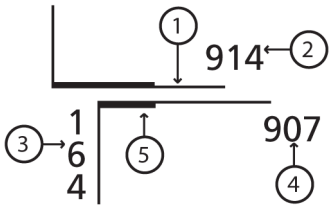


Figure 3. Interval and refractory markers



1. Refractory Period (Line)
2. A-A Interval
3. A-V Interval
4. V-V Interval
5. Absolute Refractory Period (Thicker Line)

There are two ways to change the marker configuration:
Select the Adjust Display button and select the desired configuration.
Select the marker Waveform Control button on the left of the Rhythm Display and select the desired configuration.

Table of Markers

Table 1. Markers

Marker	Description	Color
AMS	Auto mode switch event	Green
>AMS	AMS entry detected	Green
<--AMS	AMS exit detected	Green
AP	Atrial paced	Blue (paced)
AS	Atrial sensed	Red (sensed)
AS	Atrial sensed inside the refractory period	Red (sensed)
APP	Atrial pulse followed by a backup safety pulse (ACap™ Confirm)	Blue (paced)
AT/AF	An AT/AF event has been detected	Green
Autocapture	AutoCapture™ Pacing System is operating	Green
HAR	High atrial rate detection	Green
HVR	High ventricular rate detection	Green
HYS	Hysteresis Rate is started by the search timer or by a sensed event	Green
Magnet	Magnet placement detection	Green
PMT	Pacemaker-mediated tachycardia detection	Green
PVC	Premature ventricular contraction detection	Green

Table 1. Markers

Marker	Description	Color
VP	Ventricular paced	Blue (paced)
VPP	Ventricular pulse followed by a backup safety pulse (AutoCapture™ Pacing System)	Blue (paced)
VS	Ventricular sensed	Red (sensed)
VS	Ventricular sensed inside the refractory period	Red (sensed)
VSP	Ventricular safety standby beat (ventricular sensed event followed by a paced beat)	VS (red) P (blue)

EGM

EGMs (intracardiac electrograms) show the heart's electrical activity as sensed by the pacing system. The shape and size of the waveform depend on the available source EGM Configuration and the Gain setting. The number and type of configurations available depend upon the device type and implanted leads. See EGM Sources (page 5).

The Rhythm Display can show up to two EGM waveforms simultaneously in a variety of configurations. The EGM controls include:

- **The Adjust Display** button, which selects the waveform source and configuration
- **The Waveform Control** button, which sets the Gain and waveform source

EGM Sources

Unipolar Leads

- A. Unipolar Tip (Atip-Case)
- A. Sense Amp
- V. Unipolar Tip (Vtip-Case)
- V. Sense Amp
- Atip-Vtip

Unipolar/Bipolar Leads

- A. Bipolar (Atip-Aring)
- A. Unipolar Tip (Atip-case)
- A. Unipolar Ring (Aring-Case)
- A. Sense Amp
- V. Bipolar (Vtip-Case)
- V. Unipolar Tip (Vtip-Case)
- V. Unipolar Ring (Vring-Case)
- V. Sense Amp
- Vtip-Atip
- Vring-Atip
- Vtip-Aring
- Vring-Aring

Rhythm Display Setup Instructions

1. Select the Adjust Display button to the right of the Rhythm Display.

   The Adjust Display window appears.
2. Locate position 1.
3. Select the source you want to see in position 1 (ECG, EGM, or Markers, or Off).

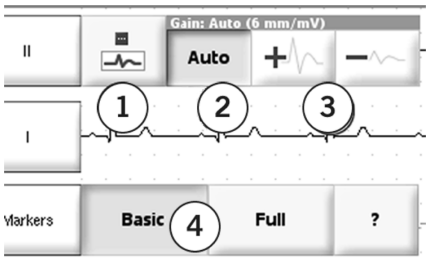
   The programmer selects a default Configuration for the Source.
4. Select the Configuration button.

   If you selected ECG or EGM for the Source, the ECG Configuration or EGM Configuration window opens. If you selected Markers, select the Basic or Full button.
5. Choose the configuration.
6. Repeat these steps for the remaining waveforms.
7. To change the default sweep speed, select the Sweep Speed button and choose a speed.
8. To set the ECG filter (to reduce electromagnetic interference), select the ECG Filter button.
9. To refresh the AutoGain settings, select the Update AutoGains button.

Waveform Control

The Waveform Control buttons on the left side of the Rhythm Display control the waveform's appearance. To open the controls, select one of the buttons. A button assigned to **Markers** opens three buttons. Buttons assigned to the **EGM** or **ECG** open four additional buttons:

Figure 4. Waveform control buttons



1. Configuration button. Opens the ECG Configuration, the EGM Configuration window, or the Markers selection buttons (Basic or Full).
2. AutoGain button. Allows the programmer to continually and automatically set the gain.
3. Plus (+) and Minus (-) buttons. Allow you to set the gain manually.
4. Markers button. Allows you to show Basic or Full markers on the Rhythm Display and provides access to Markers help.

Accessed From: Rhythm Display > Waveform Control button

Adjust Display

The Adjust Display window changes the:

- **Source** for each waveform in the Rhythm Display window (ECG, Markers, or EGM)
- **Configuration** of the waveform
- **Sweep Speed**
- **ECG Filter** to reduce electromagnetic interference

The following buttons are also available:

- **Update AutoGains**. Recalculates the gain of waveforms currently displayed in the Rhythm Display and that are set to Auto.

See also:

ECG Configuration (page 6)
EGM Configuration (page 6)
Rhythm Display Setup Instructions (page 5)

Accessed From: Rhythm Display > Adjust Display button

ECG Configuration

The ECG Configuration window changes the ECG vector on the Rhythm Display.

See ECG for a typical ECG setup (page 3).

Accessed From: Adjust Display > Configuration button

EGM Configuration

The EGM Configuration window changes the EGM source on the Rhythm Display. The available settings depend upon the programmed Lead Type setting.

See EGM Sources (page 5).

Accessed From: Adjust Display > Configuration button

Freeze Capture

The Freeze button captures the most recent 30 s of the waveform and shows the data in the Freeze Captures window. Up to six Freeze Captures are saved in the programmer memory. The controls on the Freeze Captures window include the:

- **Waveform Control** buttons, including the Hide button, which hides the selected waveform
- **Restore Channels** button, which restores the hidden waveforms
- **Sweep Speed** button
- **Show Calipers** button, which shows calipers that can be moved with button controls to display time measurements for a portion of the freeze
- **Hide Calipers** button, which toggles to the Show Calipers button
- **Scroll** buttons

You can also print the frozen waveform immediately (select the Print button) or at the end of the session (select the Print with Wrap-Up button).

Accessed From: Freeze button

FastPath™ Summary Screen

Contents:

FastPath™ Summary

Select any button on the FastPath™ Summary window for more detail.

- Alerts. Opens a list of conditions requiring attention (page 7).
- Battery Status. Opens the Battery & Leads window (page 27).
- Parameters. Opens the Brady Parameters window (page 35).
- EGMs. Opens the Episodes window (page 9).
- Event Counts. Opens the Rates Diagnostics window (page 11).
- Mode Switch or AT/AF Summary. Opens the Mode Switch Diagnostics (page 12) or AT/AF Histograms window (page 13).
- Test Results. The Capture and Sense buttons open a window for a specific test (see Tests (page 15)).
- The Lead Impedance buttons open the Lead Impedance window (page 28).
- End Session. Opens a window to print Reports (page 71) that have not been printed, and to end the session.
  - Print. Prints a Summary Report (described further in Summary Report Settings (page 71)), which includes:
  - All information on the Summary screen
  - All current parameter settings
  - All diagnostic data
  - All episode settings and data
- Perform QuickOpt™ button. Opens the QuickOpt Timing Optimization window (page 29) to evaluate and change the Paced AV Delay and Sensed AV Delay settings.

Green A Icon. Indicates an automated process (for example, AutoCapture™).

You can change the contents of the information printed in the Summary Report by selecting the Print Menu button above the FastPath Summary Screen, and then selecting Summary Report. See Summary Report Settings (page 71).

Accessed From: FastPath Summary button

Alerts

The Alerts window lists conditions or patient notifications detected since the last follow-up. The list contains buttons that open related windows. Alerts that have not been viewed are in bold.

Accessed From: FastPath Summary button > Alerts button

Patient Data

The Patient Data window displays device information and allows you to save additional data in the device's memory. The Patient Data window contains the Clear Trends button to erase long-term trend data.

Type in information using either the on-screen keyboard, which opens when you select any of the data entry buttons on the Patient Data window, or a USB keyboard connected to one of the USB ports. The data entry buttons include the:

- Device Implant Date.
- Patient Name. The first few characters appear on the Main Programming Window.
- Patient ID.
- Lead Information.
- Lead Type. Opens the Leads parameters window.

Accessed From: Main Programming window

Clear Trends

Select this button on the Patient Data window to erase all of the following trend data from the device memory:

- AutoCapture™ trend and follow-up EGMs (see the V. Capture Follow-up EGM (page 17))
- ACap™ Confirm trend and follow-up EGMs (Zephyr DR devices only, see the A. Capture Follow-up EGM (page 22))
- Amplitude trend and follow-up EGMs (see the Follow-up EGM Sense Test tab (page 17))
- Lead Impedance trend (see Lead Impedance (page 28)).

The trend data are lifetime trends and should not be cleared unless one or both of the leads has been repositioned. See Clear Diagnostics (page 59).

Accessed From: Main Programming window > Patient Data button

Note

The Note window allows you to enter additional information about the patient. The first several words of the Note appear on the Main Programming Window.

If you select the Highlight At Every Follow-up check-box, the pencil icon is highlighted on the Main Programming Window.

See Reports (page 71).

Accessed From: Main Programming window

Episodes

The Episodes button opens a window that contains the:

- **Episode Directory** (page 9)
- **Logs** (page 9)

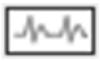
Episode Directory

The Episode Directory window lists all EGM episodes (stored EGMs) recorded by the device. Each item in the list is a button that opens an Episode Detail window. When the Episode Directory window is first opened, it displays the episodes that have been recorded since the last follow-up ("new" episodes). To view all episodes ("new" and "old"), select the **Include Old Episodes** button.

The directory contains six columns. The list can be re-sorted by selecting one of the first four column headings:

- **Alerts**. The warning icon indicates that the episode is associated with an alert.
- **Date**.
- **Time**.
- **Type**. Indicates which of the programmed Episode Triggers triggered the episode.
- **Print Icon**. Indicates that the episode has been selected for printing.
- **Status**. Indicates one of the following states:

Blue Circling Arrow Icon. The episode detail is being retrieved.



EGM Icon. The episode detail has been retrieved and is ready to view.

Cleared Icon. The episode has been cleared from the device.

Old EGM. The episode was viewed in a previous session.

No EGM. The episode is corrupted and cannot be read.

See Episode Settings (page 55).

Accessed From: Episodes > Episode Directory

Print Episodes

You can print episodes from the Episode Directory window or from the Wrap-up™ Overview window.

To print all episodes, select the Select All for Printing button from the Episode Directory. To print them while viewing the directory, select the Print Selected button. Otherwise, the episodes can be printed at wrap-up by selecting the Print Reports button on the Wrap-up Overview window.

To print a single episode:

1. Select the episode from the directory.

   The Episode Detail window opens. The Select for Printing button is checked by default.
2. Close the episode to return to the Episode Directory.
3. To print them immediately, select the Print Selected button.

   If the episode is not printed from the directory, it is stored in the Wrap-up Summary Report (see also Wrap-up Report Settings (page 71)).

Clear Episodes

To clear all episodes:

1. Select the Wrap-up™ Overview button.
2. Select the Clear Diagnostics button.
3. Select the Episodes button and Clear Selected button.

Logs

The Episodes Log window contains a list of all recorded episodes by trigger type and a button to view the AMS or AT/AF Logs.

The list contains three columns that show the:

- Programmed triggers last read
- Counts or number of all episodes that have occurred for each trigger type
- Number of EGMs (episodes) that are currently available for each trigger type

Each listed trigger is a button that opens the Episode Triggers window.

Each listed EGM is a button that opens an Episode Detail.

Accessed From: Episodes > Logs

AMS or AT/AF Logs

Select the AMS Log or AT/AF Log button to show either the AMS Log or the AT/AF Log.

This AMS Log is available if the Auto Mode Switch parameter is enabled. Otherwise, the AT/AF Log is available.

To update the Logs view, select the Read Diagnostics button on the Diagnostics window.

Episode Detail

The Episode Detail window shows the EGM and Markers data that precede and follow a recorded trigger event, with information on the date, time, trigger type, and alert status.

You can change the appearance of the waveform just as you would change a frozen waveform. See Freeze Capture (page 6).

Other controls in the Detail window include the:

- **Select for Printing** button, which places the episode in the Episode Report. See Reports (page 71).
- **Arrow** buttons, which scroll to the previous or next episode.
- **Restore Channels** button, which shows hidden waveforms.

The total time shown in the Detail depends on the settings for the Channel and Number of Stored Episodes parameters.

See Episode Triggers (page 56).

Accessed From: Episodes > Episode Directory

Diagnostics

The Diagnostics button opens a window with three tabs:

- **Rates** (page 11)
- **Mode Switch Diagnostics** (page 12) or **AT/AF Histograms** (page 13)
- **AF Suppression™ Diagnostics** (page 13)

See also:

- **Printing Diagnostics** (page 14)
- **Diagnostics Capacity** (page 14)

Rates

The Rates tab contains the Read Diagnostics button to update the diagnostics, the date of last session, the last time the data were read[4], and two diagnostic displays:

- Heart Rate Histogram
- Events

See Printing Documents (page 14)

Accessed From: Diagnostics > Rates

Heart Rate Histogram

The Heart Rate Histogram shows the distribution of all recorded paced and sensed events by rate (**min^{-1}**) and other rate-related information[5]. Each bar represents the percentage of time the patient's intrinsic or paced rate fell within a specific rate range. Each bar is divided into color-coded segments, which indicate the portion that was paced or sensed or that was a PVC.

If the Sensor parameter is programmed On or Passive, a yellow dot appears in each rate range. The position of the dot on the bar graph represents the percentage of paced events that would result if the rate was determined exclusively by response to the activity sensor.

Events

The Events display includes a bar graph that shows the percentage of the total time sampled for each event type. Thus, an Events display with an AS-VS event type of 94% indicates that during the last sampling period (defined below the graph), 94% of all events were of the AS-VS type. The percentage calculation is based on the count of the events divided by the total counts of the histogram.

Dual-chamber event types include[6]:

- **AS-VP**. Atrial sensed, ventricular paced
- **AS-VS**. Atrial sensed, ventricular sensed
- **AP-VP**. Atrial paced, ventricular paced
- **AP-VS**. Atrial paced, ventricular sensed
- **PVC**. Premature ventricular contraction (a ventricular sensed event after a VS or VP event)

Single-chamber event types include:

- **AS**. Atrial sensed
- **AP**. Atrial paced
- **VS**. Ventricular sensed
- **VP**. Ventricular paced

Above the Events graph are listed a summary of all paced events, described in the table below.

Table 2. Explanation of Event Summary Data

Event Summary Symbol	Dual-Chamber Modes	Single-Chamber Modes
AP	AP-VP + AP-VS	AP
VP	AS-VP + AP-VP	VP
AV Conduction	AP-VS + AS-VS[7]	N/A

NOTE: Rounding. Values >0 but <1 are designated as <1. Numbers from 1 to 10 are rounded up to the closest single-digit decimal number. Numbers from 10 to 99 are rounded up to the closest integer. Numbers greater than 99 and less than 100 are shown as ">99."

Reports. The Extended Diagnostics Report (see Summary Report Settings (page 71)) provides the total events counted during the sampled period as well as more detailed percentages for each event count in each rate range.

[4] The Pulse Amplitude parameter is not programmable if V. AutoCapture is On.
[5] If the device has mode-switched, the Heart Rate Histogram does not record any events. Events are recorded during mode-switch in the V Rates During AMS diagnostic window
[6] VDD mode events include AS-VP, AS-VS, and PVE.
[7] VS+[AS-VS] in VDD mode.

Mode Switch Diagnostics

The Mode Switch tab contains the Read Diagnostics button to update the diagnostics, the dates of last session and last time the data were read[8], and the:

- **AMS Summary**
- **AMS Log button**, which opens the AMS Log window
- **V Rates During AMS** (dual-chamber devices only).

See Printing Diagnostics (page 14)

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Accessed From: Diagnostics > Mode Switch

NOTE: Availability. In Sustain, Victory, and Zephyr dual-chamber devices, the Mode Switch diagnostics window is only available in certain combinations of Auto Mode Switch and Atrial Trigger settings. See the table below for a list of required settings. Select the Read Diagnostics button after any programming changes to view the histogram.

Clearing Mode-Switch Diagnostics. Reprogramming the Atrial Trigger parameter from AMS to AT/AF clears the mode-switch diagnostic data. You can also clear the diagnostics from the Clear Diagnostics window. See Wrap-up™ Overview (page 59).

Table 3. Availability of Auto Mode Switch and AT/AF Episode Histograms based on programmed settings

Atrial Trigger Setting	Auto Mode Switch Parameter Setting	Displayed Histogram
AT/AF	Off or Enabled	AT/AF Episode
AMS	Enabled	Auto Mode Switch
High A. Rate	Enabled	Auto Mode Switch
High A. Rate	Off	AT/AF Episode

AMS Summary

The AMS Summary contains information on mode-switch activity, including two histograms:

- **Peak A Rate.** Each bar represents the number of mode-switch episodes that occurred at an atrial rate within the rate range.
- **Duration.** Each bar represents the number of episodes that occurred in a single duration range.

Percentage mode switch is the time the device spent in mode switch divided by the total time sampled.

V Rates During AMS

The V Rates During AMS panel, available only for Sustain™, Victory™, and Zephyr™ dual-chamber devices, contains a histogram of ventricular activity during mode switches. Use this histogram to determine if the mode switch algorithm has successfully suppressed high ventricular pacing.

Each bar represents the percentage of the total time that ventricular events fell inside a specific rate range. Each bar is divided into paced (VP) and sensed (VS) events.

NOTE: **Rounding.** Values >0 but <1 are designated as <1. Numbers from 1 to 10 are rounded up to the closest single-digit decimal number. Numbers from 10 to 99 are rounded up to the closest integer. Numbers greater than 99 and less than 100 are shown as ">99."

Reports. The Extended Diagnostics Report (see Summary Report Settings) provides the total events counted during the sampled period as well as more detailed percentages for each event count in each rate range.

AMS Log

The AMS Log lists all mode-switch events stored in the device's memory.

The Log contains five columns. To change the sort order, select the button at the top of the desired column.

- **EGM.** An EGM icon indicates that an episode was stored with the log entry. Select the icon button to view the Episode Detail.
- **Date**
- **Time**
- **Peak Atrial Rate**
- **Duration**

Capacity. In Sustain™, Victory™, and Zephyr™ dual-chamber models the AMS Log can hold up to 32 events. The first 16 events are recorded "continuously." That is, when the memory is full, events continue to be recorded and newer events overwrite older events.

NOTE: **Rounding.** Values >0 but <1 are designated as <1. Numbers from 1 to 10 are rounded up to the closest single-digit decimal number. Numbers from 10 to 99 are rounded up to the closest integer. Numbers greater than 99 and less than 100 are shown as ">99."

Reports. The Extended Diagnostics Report (see Summary Report Settings) provides the total events counted during the sampled period as well as more detailed percentages for each event count in each rate range.

Accessed From: Diagnostics > Mode Switch > AMS Log

[8] "Last Read: Today" indicates the data were read at 12:00 am or later of the session date.

AT/AF Histograms

The AT/AF Histograms tab contains the Read Diagnostics button to update the diagnostics, the dates of last session and last time the data were read[9], and information on AT/AF events (atrial events recorded at rates higher than the Atrial Tachycardia Detection Rate). The window is divided into three sections:

- **AT/AF Summary**
- **AT/AF Log** button, which opens the AT/AF Log window
- **Episode Triggers** button, which opens the Episode Triggers window

See AT/AF Definitions (page 14), Printing Diagnostics (page 14).

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Accessed From: Diagnostics > AT/AF Histograms

NOTE: **Availability.** In Zephyr, Sustain, and Victory dual-chamber devices, the Mode Switch diagnostics window is only available in certain combinations of Auto Mode Switch and Atrial Trigger settings. See the table below for a list of required settings. Select the Read Diagnostics button after any programming changes to view the histogram.

Clearing AT/AF Diagnostics. Reprogramming the Atrial Trigger parameter from AT/AF to AMS clears the AT/AF diagnostic data.

Table 4. Availability of Auto Mode Switch and AT/AF Episode Histograms based on programmed settings

Atrial Trigger Setting	Auto Mode Switch Parameter Setting	Displayed Histogram
AT/AF	Off or enabled	AT/AF Episode
AMS	Enabled	Auto Mode Switch
High A. Rate	Enabled	Auto Mode Switch
High A. Rate	Off	AT/AF Episode

AT/AF Summary

The AT/AF Summary window shows the percentage of the total time sampled that was spent in AT/AF, the total number of AT/AF episodes, and two histograms:

- **Peak A Rate.** Each bar represents the number of AT/AF events that occurred at an atrial rate within the rate range.
- **Duration.** Each bar represents the number of AT/AF events that occurred in a single duration range.

NOTE: **Rounding.** Values >0 but <1 are designated as <1. Numbers from 1 to 10 are rounded up to the closest single-digit decimal number. Numbers from 10 to 99 are rounded up to the closest integer. Numbers greater than 99 and less than 100 are shown as ">99."

Reports. The Extended Diagnostics Report (see Summary Report Settings (page 71)) provides the total events counted during the sampled period as well as more detailed percentages for each event count in each rate range.

AT/AF Log

The AT/AF Log lists all AT/AF events stored in the device memory.

The log contains five columns. To change the sort order of the log, select the button at the top of the desired column.

- **EGM.** An EGM icon indicates that an episode was stored with the log entry. Select the icon button to view the Episode Detail.
- **Date.**
- **Time.**
- **Peak Atrial Rate.**
- **Duration.**

Capacity. The AT/AF Log can hold up to 32 events. The first 16 events are frozen in the device memory (but can be cleared). The next 16 events are recorded "continuously." That is, when the memory is full, events continue to be recorded and newer events overwrite older events.

Accessed From: Diagnostics > AT/AF Histograms > AT/AF Log

AF Suppression™ Diagnostics

The AF Suppression™ tab contains the Read Diagnostics button to update the diagnostics, the dates of last session and last time the data were read, and two displays:

- AT/AF Burden Trend
- AF Suppression

See AT/AF Definition (page 14), Printing Diagnostics (page 14)

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Accessed From: Diagnostics > AF Suppression

[9] "Last Read: Today" indicates the data were read at 12:00 am or later of the session date.

NOTE: The AF Suppression Diagnostics are only collected when AF Suppression™ Parameter is programmed On.

AT/AF Burden Trend

The AT/AF Burden Trend window shows the percentage of total time that AT/AF was detected, the total number of AT/AF episodes, and two line graphs that show up to six months of AT/AF data:

- **Weekly Percentages.** Each point equals the percentage of time the patient was in AT/AF for a seven-day period.
- **Weekly Episode Counts.** Each point equals the number of AT/AF episodes recorded in a seven-day period.

AF Suppression

The AF Suppression™ Histogram shows the percentage of total time spent in AF Suppression Parameter overdrive pacing and a graph of all atrial sensed (AS) and atrial paced (AP) overdrive events at different rate ranges. A majority of paced events indicates proper AF Suppression algorithm operation.

Each histogram bar shows the percentage of time that atrial events were recorded in a single 20 min^{-1} range and is divided into the portions that represent atrial sensed events (in red) and atrial paced (overdrive) events (in blue).

AT/AF Definition

AT/AF (atrial tachycardia/atrial fibrillation) is defined as an average atrial rate greater than the Atrial Tachycardia Detection Rate (ATDR) setting. To determine if AT/AF has occurred, the device computes an average atrial rate. If that average and the current rate are higher than the setting for the ATDR parameter, the device records a single episode of AT/AF. The calculation does not distinguish between tachycardia and fibrillation.

See Atrial Trigger (page 56).

NOTE: **Rounding.** Values >0 but <1 are designated as <1. Numbers from 1 to 10 are rounded up to the closest single-digit decimal number. Numbers from 10 to 99 are rounded up to the closest integer. Numbers greater than 99 and less than 100 are shown as ">99."

Reports. The Extended Diagnostics Report (see Summary Report Settings) provides the total events counted during the sampled period as well as more detailed percentages for each event count in each rate range.

Printing Diagnostics

Diagnostics are printed with the Summary Report and can be printed in an abbreviated or an extended form. For more information, see Summary Report Settings (page 71).

Diagnostics Capacity

The AF Suppression™ Diagnostics can hold up to 4,294,967,296 events in a single rate-range bin. New data overwrite older data in a continuous (first-in, first-out) data collection.

The Rates, Mode Switch Diagnostics, and AT/AF Histograms can hold up to 16,777,215 events in a single rate-range bin. When a single bin fills for any histogram, the device freezes data collection for all diagnostics.

The device records every event. If the pacing rate remained steady at 60 min^{-1}, the rhythm diagnostics memory would be filled in approximately 194 days. However, events that occur in a variety of rate ranges result in a much longer period of data collection.

Tests

The Tests window contains the following tabs:

- **Capture & Sense** (page 15)
- **Battery & Leads** (page 27)
- **Sensor** (page 28)
- **QuickOpt™ Timing Optimization (Zephyr™ DR devices only)** (page 29)
- **NIPS** (page 31)
- **Temporary Pacing** (page 34)

Capture & Sense

The Capture & Sense Test window shows recent capture and sense test results. To start a test, select any button.

A green button indicates that the test has not been performed in the current session. A blue button indicates that a test has been performed.

- **V. Capture Test** (page 15)
- **A. Capture Test** (page 20) (Sustain™, Victory™, Zephyr™ SR Devices)
- **A. Capture Test** (page 20) (Zephyr DR Devices)
- **Sense Tests** (page 25)

Accessed From: Tests > Capture & Sense

V. Capture Test

Test Examples

Figure 5. Tests: V. Capture Test window: V. AutoCapture™ Threshold Test Start

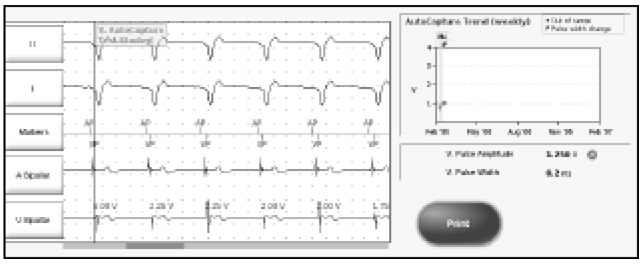
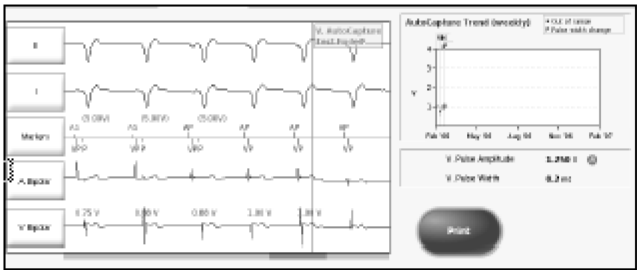


Figure 6. Tests: V. Capture Test window: V. AutoCapture™ Threshold Test Finish



See V. Capture Test Instructions (page 16).

The V. Capture Test measures ventricular capture threshold to help determine an appropriate Pulse Amplitude setting. Two test methods are available:

- **Decrement**, used for manual tests
- **AutoCapture™**, used for automatic tests

The Ventricular Capture Test window contains up to four tabs:

- **Perform Test**, used to set up and run the test
- **Follow-up EGM**, shows the most recent out-of-clinic, automatic capture threshold measurements (Follow-up EGM) recorded within the past 24 hours
- **This Session**, reports the results from the current session
- **Last Session**, reports the results from the last session

Accessed From: Tests > Capture & Sense > Capture/Ventricle button

Perform Test

The Perform Test window contains a test button and the:

- **Current permanent settings** for the test-related parameters. Select the "..." button for more settings.
- **Test Options** button. Chooses the capture test method.
- **Additional Parameters** button. Opens a window to temporarily set other test parameters.
- **V. AutoCapture™ Setup** button. Runs the V. AutoCapture Setup procedure to ensure that the AutoCapture™ Pacing System can operate successfully.
- **Start Temporary** button.

V. Capture Test Instructions

Decrement

The Decrement method manually determines the V. capture threshold.

NOTE: You can run the V. AutoCapture™ Setup test when Test Option is set to Decrement.

1. Select the Tests button.
2. Select the Capture Ventricle button.
3. The Follow-up EGM window appears.
4. Select the Perform Test tab.
5. If the AutoCapture Test Method is indicated on the Test Options button or if you want to change the Number of Cycles/Step setting, select the Options button. Otherwise, skip to Step 9.
6. For the Test Method parameter, select the Decrement setting.
7. Select the setting for the Number of Cycles/Step parameter.

   This parameter determines how many paced and sensed cycles the programmer counts before it reduces the Pulse Amplitude setting to the next step.
8. Close the Test Options window.

   The Perform Test window appears.
9. Review the temporary settings for the test's Pulse Amplitude[10], Mode and Base Rate settings and reset any parameters that require it. Review the Additional Parameters button to determine if these need to be reset. If necessary, select the Waveform Control button on the Rhythm Display to reset the waveform.

   To program the device to the temporary settings before the test begins, select the Start Temporary button.
10. To begin the test, select the Hold to Test button.

    The device delivers the starting pulse for the programmed Number of Cycles/Step. After the cycles have elapsed, the device's Pulse Amplitude setting is reduced to the next setting, until you end the test or the device reaches 0.25 V.
11. Watch the EGM for loss of capture. When this occurs, release the test button.

    The This Session window appears with the test results and a button to program the Pulse Amplitude setting.

    NOTE: You can stop the test at any time by releasing the Hold to Test button.

AutoCapture

The AutoCapture method automatically determines the V. capture threshold when V. AutoCapture is programmed On.

1. Select the Tests button.
2. Select the Capture Ventricle button.

   The Follow-up EGM window appears.
3. Select the Perform Test tab.
4. If the Decrement Test Method is indicated on the Options button, select the Test Options button. Otherwise, skip to Step 7.

   NOTE: When you select the V. AutoCapture Setup test button, the Test Method is automatically reset to the AutoCapture setting.
5. For the Test Method parameter, select the AutoCapture setting.
6. Close the Test Options window.

   The Perform Test window appears.

[10] The Pulse Amplitude parameter is not programmable if V. AutoCapture is On.

7. Review the temporary settings for the test's Mode and Base Rate settings and reset any parameters that require it. Review the Additional Parameters button to determine if these need to be reset. If necessary, select the Waveform Control button on the Rhythm Display to reset the waveform.

   To program the device to the temporary settings before the test begins, select the Start Temporary button.

8. Select the Start Test button.

   You can monitor the test from the waveform. Select the Cancel button to stop the test. When the test is complete, the This Session window appears with the test results.

   NOTE: Selecting the Cancel button aborts the test and does not record a result. Before you run the AutoCapture method of the V. Capture Test, run the V. AutoCapture Setup test to ensure proper AutoCapture operation.

Follow-up EGM

The Follow-up EGM window is available when V. AutoCapture™ is On. The window contains:

- **A Follow-up EGM** showing five complexes from the most recent out-of-clinic automatic capture threshold measurement that was used to identify capture (the complexes are shown chronologically from left to right)
- The **AutoCapture Trend**, a line graph showing up to 52 weeks of measured capture threshold readings[11]
- The **current programmed settings** for the V. Pulse Width and V. Pulse Amplitude parameters (the green A symbol indicates automatic operation)
- **Print** button

  NOTE: If the tab is labeled "Today," the EGMs were recorded within the last 24 hours. Otherwise, the tab displays the date of the last recording.

  Only automatic, out-of-clinic measurements are saved in the AutoCapture Trend. Measurements obtained during a programming session are noted in the trend with a green dot, but are not saved in memory.

Accessed From: Tests > Capture & Sense > Capture/Ventricle button > Today/[Date] tab

This Session

This window contains the V. Capture Test waveform recorded during the most recent programming session. You can view, change, or print the waveform like any Freeze Capture.

Decrement Method. If a manual test method was used, the window shows:

- A "Capture Lost" flag on the waveform at the programming step (vertical line) next to where the test was ended. If this flag is not correctly set, touch the strip where the capture was lost to reset the flag.
- If the V. AutoCapture™ setting is On, the Automatic V. Pulse Amplitude setting
- If the V. AutoCapture setting is Off, the Safety Margin (ratio of the V. Pulse Amplitude setting to the measured capture threshold), the setting for V. Pulse Width, and a button to program the V. Pulse Amplitude parameter

The Safety Margin is highlighted in orange if the ratio is less than 2:1 or in blue if it is greater than 2:1.

AutoCapture Method. If the AutoCapture test method was used, the window shows:

- The Automatic V. Pulse Amplitude and the V. Pulse Width settings.
- The AutoCapture Trend, a line graph of measured capture threshold readings over time. Threshold samples are recorded in the Trend every seven days.

  NOTE: Only automatic, out-of-clinic measurements are saved in the AutoCapture Trend. Measurements obtained during a programming session are noted in the trend with a green dot, but are not saved in memory.

Accessed From: Tests > Capture & Sense > Capture/Ventricle button > This Session tab

Last Session

The Last Session window contains the results of the last recorded V. Capture test.

If the AutoCapture™ test method was used, the window also shows:

- The AutoCapture Trend, a line graph of measured capture threshold readings over time. Threshold samples are recorded in the Trend every seven days.

NOTE: Only automatic, out-of-clinic measurements are saved in the AutoCapture Trend. Measurements obtained during a programming session are noted in the trend with a green dot, but are not saved in memory.

Accessed From: Tests > Capture & Sense > Capture/Ventricle button > Last Session tab

Test Options

From the Test Options window, select a method to determine ventricular capture. The options are:

- **Decrement**, which manually tests for capture threshold.
- **Number Cycles/Step**. This parameter determines how many paced and sensed cycles the programmer counts before it reduces the Pulse Amplitude setting to the next step.
- **AutoCapture™**, which automatically measures capture threshold and sets the Pulse Amplitude parameter to 0.25 V above the measured capture threshold. AutoCapture is the default option if the V. AutoCapture parameter is On. The V. AutoCapture parameter does not have to be On to use this test method.

[11] Samples are recorded every seven days.

NOTE: If the AutoCapture method is selected, you should first run the V. AutoCapture Setup test to ensure that the AutoCapture Pacing System can operate.

Accessed From: Tests > Capture & Sense > Capture/Ventricle button > Test Settings tab > Options button

Additional Parameters

The Additional Parameters window temporarily sets other test parameters. Temporarily programmed parameter settings are restored when the test ends or is canceled.

Parameters that can be temporarily programmed include:

- Pulse Configuration
- Pulse Width
- V. Refractory Period
- Backup Pulse Configuration (AutoCapture™ method only)
- Mode
- Base Rate
- AutoCapture Paced/Sensed AV Delay (Zephyr™ DR AutoCapture method only)
- Starting Pulse Amplitude (Decrement method only)
- Paced AV Delay (Decrement method only)
- Sensed AV Delay (Decrement method only)

Accessed From: Tests > Capture & Sense > Capture/Ventricle button > Test Settings tab > Additional Parameters button

V. AutoCapture Setup

Test Examples

The V. AutoCapture™ Setup Test:

- Determines if the pacing system can operate the AutoCapture Pacing System.
- Programs the V. AutoCapture parameter On or Off.
- Temporarily programs the Mode and Base Rate parameters, as well as Additional Parameters for the test.
- Shows test results.

NOTE: V. AutoCapture does not have to be programmed On to perform the setup. Conduct the V. AutoCapture Setup test when V. AutoCapture is first programmed on.

This window contains up to three tabs:

- **Perform Test**, used to set up and run the test
- **This Session**, reports the results from the current session
- **Last Session**, reports the results from the last session

Accessed From: Tests > Capture & Sense > Capture/Ventricle button > Perform Test tab > AutoCapture Setup button

Perform Test

The Perform Test window contains the **Start Test** button and the:

- **Current permanent settings** for the Mode and Base Rate parameters (and the Paced/Sensed AV Delay parameters in some models). Select the "..." button for more settings.
- **Additional Parameters** button. Opens a window to temporarily set other test parameters.
- **Start Temporary** button.

V. AutoCapture Setup Test Instructions

To perform the AutoCapture™ Setup:

1. Select the Tests button.
2. Select the Capture Ventricle button.
3. Select the Perform Test tab.
4. Select the AutoCapture Setup button.

   The V. AutoCapture Setup window appears.
5. Select the temporary test settings for the Mode and Base Rate parameters. Select the “...” button for additional options. Select the Additional Parameters button for more choices.

   NOTE: The temporary values you selected for Pulse Width, Backup Pulse Configuration, V. Pulse Configuration (Zephyr devices only), and AutoCapture Paced/Sensed AV Delay (Zephyr devices only) from the Additional Parameters window are permanently programmed when the V. AutoCapture Setup Test is successful and when you program the V. AutoCapture parameter On from the results (This Session) window. All other parameters are restored to their permanent settings when the test ends or is canceled.

   To program the device to the temporary settings before the test begins, select the Start Temporary button.

   NOTE: In most cases, no parameter adjustment is necessary. The test may prompt you to adjust certain parameters if there are fusion beats or insufficient paced activity.

6. Select the Start Test button.

   A “Test in Progress” status message appears in the upper right-hand corner.
   The programmer temporarily reprograms the permanent settings to ensure that the device paces the ventricle and inhibits intrinsic activity.
   To stop the test, press the Cancel button.
   When the test is complete, the test results appear in the This Session window.

This Session

This window contains the:

- **AutoCapture™ Setup Test** recommendation (on tab)
- **Test waveform freeze** (to adjust, see Freeze Capture (page 6))
- Buttons to program the V**. AutoCapture parameters**
- **Print and Program** buttons.

Accessed From: Tests > Capture & Sense > Capture/Ventricle button > Test Settings tab > AutoCapture Setup button > This Session tab

Test Result Messages

The following messages can be displayed on the This Session window:

Table 5. V. AutoCapture Setup test messages

Message	Interpretation
"Recommended"	The implanted pacing system can successfully operate the AutoCapture Pacing System.
“Not Recommended”	The implanted pacing system cannot successfully operate the AutoCapture Pacing System.
“The Lead Polarization safety margin is below 1.7:1.”	The ratio of the evoked response sensitivity to the lead polarizations too small for the AutoCapture Pacing System to operate reliably.
“The Lead Polarization is too high”	The lead polarization (background noise) is greater than 4 mV and is interfering with the sensing of the evoked response.
“Safety margins not met”	The Lead polarization is too high, the evoked response is too low, or the evoked response safety margin is not met.
“The Evoked Response safety margin is below 1.8:1”	The ratio of evoked response is less than 180% larger than the setting for E/R Sensitivity.

This Session

This window contains the:

- **AutoCapture™ Setup Test** recommendation (on tab)
- **Test waveform freeze** (to adjust, see Freeze Capture (page 6))
- **Test results**, see Test Result Messages (page 19)
- Button to program the **V. AutoCapture parameter**
- **Print and Program** buttons

Accessed From: Tests > Capture & Sense > Capture/Ventricle button > Test Settings tab > AutoCapture Setup button > This Session tab

Test Result Messages

The following messages can be displayed on the This Session window:

Table 6. V. AutoCapture Setup test messages

Message	Interpretation
“Recommended (V. Pulse Configuration)”	The implanted pacing system can successfully operate the AutoCapture Pacing System at the current V. Pulse Configuration setting.
“Not Recommended (V. Pulse Configuration)”	The implanted pacing system cannot successfully operate the AutoCapture Pacing System at the current V. Pulse Configuration setting.
“Safety margins not met”	The ratio of the evoked response sensitivity to the lead polarization is inadequate for the AutoCapture Pacing System to operate reliably.
“Test cannot be run due to insufficient paced activity or possible fusion beats”	The system is not able to correctly sense paced activity.

Last Session

The Last Session window reports the results of the last recorded V. AutoCapture™ Setup Test.

See Test Result Messages (page 19).

Accessed From: Tests > Capture & Sense > Capture/Ventricle button > Test Settings tab > AutoCapture Setup button > Last Session tab

Additional Parameters

The Additional Parameters window sets additional test parameters.

> NOTE: The temporary values you selected for Pulse Width and Backup Pulse Configuration (Zephyr™ devices only) from the Additional Parameters window are permanently programmed if the V. AutoCapture™ Setup Test is successful and you program the V. AutoCapture parameter On from the results (This Session) window. All other parameters are restored to their permanent settings when the test ends or is canceled.

Accessed From: Tests > Capture & Sense > Capture/Ventricle button > Test Settings tab > AutoCapture Setup button > Perform Test tab > Additional Parameters button

A. Capture Test

(Sustain™, Victory™, Zephyr™ SR Devices)

See A. Capture Test Instructions (page 20).

The A. Capture Test measures atrial capture threshold to help determine an appropriate A. Pulse Amplitude setting.

The Atrial Capture Test window contains up to three tabs:

- **Perform Test**, used to set up and run the test
- **This Session**, reports the results from the current session
- **Last Session**, reports the results from the last session

Accessed From: Tests > Capture & Sense > Capture/Atrium button

Perform Test

The Perform Test window contains the Hold to Test button and the:

- **Current permanent settings** for the Mode, Base Rate, Paced/Sensed AV Delay (dual-chamber modes), and Starting Pulse Amplitude parameters. Select the "..." button for more settings.
- **Test Options** button. Sets the Number of Cycles/Step parameter.
- **Additional Parameters** button. Opens a window to temporarily set other test parameters.
- **Start Temporary** button.

A. Capture Test Instructions

1. Select the Tests button.
2. Select the Capture Atrium button.
3. If you want to change the setting for the Number of Cycles/Step parameter (indicated on the Test Options button), select the Options button. Otherwise, skip to Step 6.
4. Select the setting for the Number of Cycles/Step parameter.

   This parameter determines how many paced and sensed cycles the programmer counts before it reduces the Pulse Amplitude setting to the next step.
5. Close the Test Options window.

   The Perform Test window appears.
6. Review the temporary settings for the test's Pulse Amplitude, Mode and Base Rate and reset any parameters that require it. Review the Additional Parameters button to determine if these need to be reset. If necessary, select the Waveform Control button on the Rhythm Display to reset the waveform.

   To program the device to the temporary settings before the test begins, select the Start Temporary button.
7. To begin the test, select the Hold to Test button.

   The device delivers the starting pulse for the programmed Number of Cycles/Step parameter. After the cycles have elapsed, the device's Pulse Amplitude value is reduced to the next setting, until you end the test or the device reaches 0.25 V.
8. Watch the EGM for loss of capture. When this occurs, release the test button.

   The This Session window appears with the test results and a button to program the A. Pulse Amplitude parameter.

   NOTE: You can stop the test at any time by releasing the Hold to Test button.

A. Capture Test

(Zephyr™ DR Devices)

See A. Capture Test Instructions (page 21).

The A. Capture Test measures atrial capture threshold to help determine an appropriate Pulse Amplitude setting.

Two test methods are available:

- **Decrement**, used for manual tests
- **ACap™ Confirm**, used for automatic tests in devices with ACap Confirm Parameter

The Atrial Capture Test window contains up to four tabs:
- Perform Test, used to set up and run the test
- Follow-up EGM, shows the most recent out-of-clinic, automatic capture threshold measurements (Follow-up EGM)
- This Session, reports the results from the current session
- Last Session, reports the results from the previous programming session

Accessed From: Tests > Capture & Sense > Capture/Atrium button

Perform Test

The Perform Test window contains a test button and the:
- **Current permanent settings** for the starting Pulse Amplitude (Decrement only), Paced/Sensed AV Delay (Decrement only), Mode and Base Rate parameters. Select the "..." button for more settings.
- **Test Options** button. Chooses the capture test method.
- **Additional Parameters** button. Opens a window to temporarily set other test parameters.
- **ACap™ Confirm Setup** button. Runs the ACap Confirm Setup procedure to ensure that the ACap Confirm function can operate successfully.

A. Capture Test Instructions

Decrement

The Decrement method manually determines the A. capture threshold.

1. Select the Tests button.
2. Select the Capture Atrium button.
3. If the ACap™ Confirm Test Method setting is indicated on the Test Options button or if you want to change the Number of Cycles/Step setting, select the Options button. Otherwise, skip to Step 7.
4. For the Test Method parameter, select the Decrement setting.
5. Select the setting for the Number of Cycles/Step parameter.

   This parameter determines how many paced and sensed cycles the programmer counts before it reduces the Pulse Amplitude setting to the next step.
6. Close the Test Options window.

   The Perform Test window shows the test settings. A blue button indicates a permanent setting. A green button indicates a temporary setting. White buttons show additional, unprogrammed settings.
7. To reset any parameter, select one of the white temporary buttons or the "..." button for additional settings. Select the Additional Parameters button to determine if other test parameters need to be reset. If necessary, select the Waveform Control button on the Rhythm Display to reset the waveform.

   To program the device to the temporary settings before the test begins, select the Start Temporary button.
8. To begin the test, select the Hold to Test button.

   The device delivers pulses at the Starting Pulse Amplitude setting for the Number of Cycles/Step setting. After the cycles have elapsed, the device lowers its Pulse Amplitude by 0.25 V and counts cycles before lowering the Pulse Amplitude setting again. The setting continues to decrease until you release the Hold to Test button or the setting reaches 0.25 V.
9. Watch the EGM for loss of capture. When this occurs, release the test button.

   The This Session window appears with the test results and a button to program the Pulse Amplitude setting.

   NOTE: You can stop the test at any time by releasing the Hold to Test button.

ACap™ Confirm

The ACap™ Confirm method automatically determines the A. capture threshold.

1. Select the Tests button.
2. Select the Capture Atrium button.
3. If the Test Options button lists the Decrement setting for the Test Method parameter, select the Options button. Otherwise, skip to Step 6.
4. For the Test Method parameter, select the ACap Confirm setting.

   NOTE: When you select the ACap Confirm Setup test button, the Test Method parameter is automatically reset to the ACap Confirm setting.
5. Close the Test Options window.
6. If the ACap Confirm Setup button is outlined in red (this indicates that the test has not been conducted or that ACap Confirm is not recommended), select the button and complete the setup before returning to Step 7. See ACap Confirm Setup.

The Perform Test window shows the test settings. A blue button indicates a permanent setting. A green button indicates a temporary setting. White buttons show additional, unprogrammed settings.

7. To reset any parameter, select one of the white temporary buttons or the "..." button for additional settings. Select the Additional Parameters button to determine if other test parameters need to be reset. If necessary, select the Waveform Control button on the Rhythm Display to reset the waveform.

   To program the device to the temporary settings before the test begins, select the Start Temporary button.

8. Select the Start Test button.

   You can monitor the test from the waveform. When the test is complete, the This Session window appears with the test results.

   NOTE: Selecting the Cancel button aborts the test and does not record a result. Before you use the ACap Confirm method of the A. Capture Test, conduct the ACap Confirm Setup test to correctly operate the ACap Confirm function.

Follow-up EGM

The Follow-up EGM window is available when ACap™ Confirm Parameter is set to On or Monitor. The window contains:

- **A Follow-up EGM** showing five complexes from the most recent out-of-clinic automatic capture threshold measurement that was used to identify capture (the complexes are shown chronologically from left to right)
- **The ACap Confirm Trend**, a line graph of up to 52 weeks of measured capture threshold readings which includes the average and range of capture thresholds[12]
- **The current programmed settings** for relevant parameters (the green A symbol indicates automatic operation)
- **Print** button

  NOTE: If the tab is labeled "Today," the EGMs were recorded within the last 24 hours. Otherwise, the tab displays the date of the last recording.

  Only automatic, out-of-clinic measurements are saved in the ACap Confirm Trend. Measurements obtained during a programming session are noted in the Trend with a green dot, but are not saved in memory.

Accessed From: Tests > Capture & Sense > Capture/Atrium button > Today/[Date] tab

This Session

This window contains the results of the A. Capture Test recorded during this programming session. You can view, change, or print the waveform like any Freeze Capture.

The test sets a "Capture Lost" flag at the programming step (vertical line) next to where the test was ended. If this flag is not correctly set, touch the strip where the capture was lost to reset the flag.

The window shows the Safety Margin (ratio of the A. Pulse Amplitude setting to the measured atrial capture threshold), the setting for the A. Pulse Width parameter, and a button for programming the A. Pulse Amplitude parameter.

See Test Options (page 23).

Accessed From: Tests > Capture & Sense > Capture/Atrium button > This Session tab

This Session

This window contains the A. Capture Test waveform recorded during the most recent programming session. You can view, change, or print the waveform like any Freeze Capture.

Decrement Method. If a manual test method was used, the window shows:

- A "Capture Lost" flag on the waveform at the programming step (vertical line) next to where the test was ended. If this flag is not correctly set, touch the strip where the capture was lost to reset the flag.
- The current A. Pulse Width setting.
- If the ACap™ Confirm setting is On, the automatic A. Pulse Amplitude setting.
- If the ACap Confirm Parameter setting is set to Off or Monitor, a button to program the A. Pulse Amplitude parameter and the current Safety Margin (ratio of the A. Pulse Amplitude setting to the measured capture threshold).

The Safety Margin is highlighted in orange if the ratio is less than 2:1 or in blue if it is greater than 2:1.

ACap Confirm Method. If the ACap Confirm test method was used, the window shows:

- The test waveform and its controls
- Relevant parameter settings
- The **ACap Confirm Trend**, a line graph of up to 52 weeks of measured capture threshold readings which includes the average and range of capture thresholds[13].

  NOTE: Only automatic, out-of-clinic measurements are saved in the ACap Confirm Trend. Measurements obtained during a programming session are noted in the trend with a green dot, but are not saved in memory.

Accessed From: Tests > Capture & Sense > Capture/Atrium button > This Session tab

Last Session

The Last Session window contains the results of the last recorded A. Capture Test (see A. Capture Test (page 20) or A. Capture Test (Zephyr™ devices only (page 20)).

Accessed From: Tests > Capture & Sense > Capture/Atrium button > Last Session tab

[12] Samples are recorded every seven days.
[13] Samples are recorded every seven days.

Test Options

From the Options window, select a setting for the Number of Cycles/Step parameter. This parameter determines how many paced and sensed cycles the programmer counts before it reduces the Pulse Amplitude setting to the next step.

Accessed From: Tests > Capture & Sense > Capture/Atrium button > Test Settings tab > Options button

Additional Parameters

The Additional Parameters window temporarily sets other test parameters. Permanently programmed parameter settings are restored when the test ends or is canceled.

Parameters that can be temporarily programmed include:

- **A. Pulse Configuration**
- **A. Pulse Width**
- **A. Refractory Period (PVARP)**
- **Mode**
- **Base Rate**
- **Starting A. Pulse Amplitude** (Decrement Test Method only)
- **A. Backup Pulse Configuration** (ACap™ Confirm Test Method only)
- **Paced AV Delay** (Decrement Test Method only)
- **Sensed AV Delay** (Decrement Test Method only).

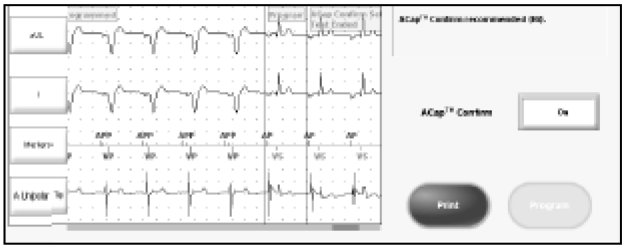
Accessed From: Tests > Capture & Sense > Capture/Atrium button > Test Settings tab > Additional Parameters button

ACap™ Confirm Setup

(Zephyr™ DR Devices)

Test Examples

Figure 7. ACap™ Confirm Setup test results window in the Zephyr DR device



See Test Examples (page 18).

The ACap™ Confirm Setup Test:

- Determines if the pacing system can operate the ACap Confirm function in the atrium.
- Sets the ACap Confirm Parameter to On, Off, or Monitor for later programming.
- Temporarily programs the Mode and Base Rate parameters, as well as Additional Parameters for the test.
- Shows past test results.

NOTE: The ACap Confirm parameter does not have to be programmed to On or Monitor to perform the setup.

Conduct the ACap Confirm Setup test when the ACap Confirm parameter is first programmed to On or Monitor.

This window contains up to three tabs:

- **Perform Test**, used to set up and run the test
- **This Session**, reports the results from the current session
- **Last Session**, reports the results from the last session

Accessed From: Tests > Capture & Sense > Capture/Atrium button > Perform Test tab > ACap Confirm Setup button

Perform Test

The Perform Test window contains the Start Test button and the:

- **Current permanent settings** for the Mode and Base Rate parameters. Select the "..." button for more settings.
- **Additional Parameters** button. Opens a window to temporarily set other test parameters.
- **Start Temporary** button.

ACap™ Confirm Setup Test Instructions

To perform the ACap™ Confirm Setup:

1. Select the Tests button.
2. Select the Capture Atrium button.
3. Select the ACap Confirm Setup button.

   The Perform Test window shows the test settings. A blue button indicates a permanent setting. A green button indicates a temporary setting. White buttons show additional, unprogrammed settings.
4. To reset any parameter, select one of the white temporary buttons or the "..." button for additional settings. Select the Additional Parameters button to determine if other test parameters need to be reset. If necessary, select the Waveform Control button on the Rhythm Display to reset the waveform.

   Program the Base Rate parameter to ensure atrial pacing during the Setup Test. To program the device to the temporary settings before the test begins, select the Start Temporary button.

   NOTE: The temporary values you selected for Pulse Width and Backup Pulse Configuration from the Additional Parameters window are permanently programmed If the ACap Confirm Setup Test is successful and you program the ACap Confirm parameter to On or Monitor from the results (This Session) window. All other parameters are restored to their permanent settings when the test ends or is canceled.
5. Select the Start Test button.

   The programmer temporarily programs the test settings to ensure that the device paces the atrium and inhibits intrinsic activity. During the test, the A. EGM Configuration parameter is set to A. Unipolar Tip, and the V. EGM Configuration parameter is turned off.

   When the test is complete, the results appear in the This Session window.

   NOTE: Selecting the Cancel button aborts the test and does not record a result.

This Session

This window contains the:

- **ACap™ Confirm Setup Test** recommendation (on tab)
- **Test waveform freeze** (to adjust, see Freeze Capture (page 6))
- **Test results**, see Test Result Messages (page 24)
- **ACap Confirm Parameter parameters**
- **Print and Program** buttons

Accessed From: Tests > Capture & Sense > Capture/Atrium button > Test Settings tab > ACap Confirm Setup button > This Session tab

Test Result Messages

The following messages may be displayed on the This Session window:

Table 7. ACap™ Confirm Setup test messages

Message	Interpretation
"Recommended (A. Pulse Configuration)"	The implanted pacing system can successfully operate the ACap Confirm function at the current A. Pulse Configuration setting.
"Not Recommended (A. Pulse Configuration)"	The implanted pacing system cannot successfully operate the ACap Confirm function at the current A. Pulse Configuration setting.
"Safety margins not met"	The ratio of the evoked response sensitivity to the lead polarization is inadequate for the ACap Confirm function to operate reliably.
"ACap Confirm Setup canceled due to insufficient atrial paced activity or possible fusion: In order to complete the test, the device must be able to pace at a rate below 120 min^{-1}."	Fusion beats or two consecutive P-waves were detected during the test.

Last Session

The Last Session window reports the results of the last recorded ACap™ Confirm Setup Test. See Test Result Messages (page 24).

Accessed From: Tests > Capture & Sense > Capture/Atrium button > Test Settings tab > ACap Confirm Setup button > Last Session tab

Additional Parameters

The Additional Parameters window sets additional test parameters.

NOTE: The temporary values you selected for Pulse Width and Backup Pulse Configuration from the Additional Parameters window are permanently programmed If the ACap™ Confirm Setup Test is successful and you program the ACap Confirm

parameter to On or Monitor from the results (This Session) window. All other parameters are restored to their permanent settings when the test ends or is canceled.

Accessed From: Tests > Capture & Sense > Capture/Atrium button > Test Settings tab > ACap Confirm Setup button > Perform Test tab > Additional Parameters button

ACap™ Confirm Not Recommended

The test has found that the margin between the evoked response and the lead polarization is not adequate to operate the ACap™ Confirm parameter.

Please note the number (n) following the text "Safety Margins not met (n)" if you contact Technical Support.

Sense Tests

See Sense Test Instructions (page 25).

Sense Threshold tests measure atrial or ventricular signal amplitude and help determine an appropriate Sensitivity setting. Two test methods are available:

- **Increment**, used for manual tests
- **Automatic**, for automatic tests

See Test Options (page 27).

The Sense Test window contains up to four tabs:

- **Perform Test**, used to set up the test
- **Follow-up EGM**, reports the most recent automatic, out-of-clinic measurements
- **Last Session**, reports the results from the last session.
- **This Session**, reports the results from the current session

Accessed From: Tests > Capture & Sense > Sense/Ventricle or Sense/Atrium button

Perform Test

The Perform Test window contains the test button and the:

- **Current permanent settings** for the Starting Sensitivity (Increment only), Mode, Base Rate, and Paced/Sensed AV Delay (dual-chamber modes) parameters. Select the "..." button for more settings.
- **Test Options** button. Chooses the sense test method.
- **Additional Parameters** button. Opens a window to temporarily set other test parameters.
- **Start Temporary** button.

Sense Test Instructions

Increment

The Increment method manually determines the signal amplitude.

1. Select the Tests button.
2. Select the Sense Atrium or Sense Ventricle button.
3. If the Automatic Test Method is indicated on the Test Options button or if you want to change the setting for the Number of Cycles/Step parameter for the Increment test, select the Options button. Otherwise, skip to Step 7.
4. For Test Method, select Increment.
5. Select the setting for the Number of Cycles/Step parameter.

   This parameter determines how many paced and sensed cycles the programmer counts before it increases the Sensitivity setting to the next step[14].
6. Close the Test Options window.

   The Perform Test window appears.
7. Review the temporary settings for the test's starting Sensitivity, Mode, Base Rate, and Paced/Sensed AV Delay parameters and reset any parameters that require it. Review the Additional Parameters button to determine if these need to be reset. If necessary, select the Waveform Control button on the Rhythm Display to reset the waveform.

   To program the device to the temporary settings before the test begins, select the Start Temporary button.
8. To begin the test, select the Hold to Test button.

   The device senses at the starting Sensitivity setting for the programmed Number of Cycles/Step parameter. After the cycles have elapsed, the Sensitivity value is increased (mV value) to the next setting, until you remove your finger from the Hold to Test button or the device reaches the maximum Sensitivity setting and automatically ends the test.
9. Watch the ECG for loss of sensing. When this occurs, release the Hold to Test button.

   The This Session window appears with the test results.

Automatic

The Automatic method automatically determines the signal amplitude.

[14] When the Sensitivity setting (mV) is increased, the actual sensitivity of the device decreases. Thus, as the test progresses, the device becomes less able to sense intrinsic activity.

1. Select the Tests button.
2. Select the Sense Atrium or Sense Ventricle button.
3. If the Options button indicates Increment as the Test Option, select the Test Options button. If Automatic is listed, skip to Step 6.
4. For Test Method, select Automatic.
5. Close the Test Options window.

   The Perform Test window appears.
6. Review the temporary settings for the test's Mode, Base Rate, and Paced/Sensed AV Delay parameters and reset any parameters that require it. Review the Additional Parameters button to determine if these need to be reset. If necessary, select the Waveform Control button on the Rhythm Display to reset the waveform.

   To program the device to the temporary settings before the test begins, select the Start Temporary button.
7. To begin the test, select the Start Test button.

   As the test proceeds, the programmer increases the Sensitivity setting (mV setting)[15] from the currently programmed setting. You can monitor the test from the waveform.
   The test completes automatically, and the This Session window appears with the test results.

Follow-up EGM

The Follow-up EGM window is available if the A. or V. Amplitude Monitoring parameter was On at any point prior to the programming session. The window contains:

- A **Follow-up EGM** showing five complexes from the most recent out-of-clinic automatic P-wave or R-wave measurement (the complexes are shown chronologically from left to right).
- The **Amplitude Trend**, a line graph of median weekly sense threshold measurements over time. The Trend displays the Sense Configuration setting programmed at the time the weekly sample was taken.
- The **current programmed setting** for the A. or V. Sensitivity parameter (the green A symbol indicates automatic monitoring).
- **Print** button.

  NOTE: If the tab is labeled "Today," the EGMs were recorded within the last 24 hours. Otherwise, the tab displays the date of the last recording.

  Only automatic, out-of-clinic measurements are saved in the Amplitude Trend. Measurements obtained during a programming session are noted in the trend with a green dot, but are not saved in memory.

Accessed From: Tests > Capture & Sense > Sense/Ventricle button or Sense/Atrium > Today/[Date] tab

This Session

The This Session window contains the results of the Sense Test recorded during this programming session. You can view, change, or print the waveform like any Freeze Capture.

The window also contains:

- A button for programming the A. or V. Sensitivity parameters.
- The Safety Margin (ratio of the measured signal amplitude to the Sensitivity setting)

The Safety Margin is highlighted in orange if the ratio is less than 2:1 or in blue if it is greater than 2:1.

Increment Method. If a manual test method was used, the window also shows:

- A "Sensing Lost" flag on the waveform at the programming step (vertical line) next to where the test was ended. If this flag is not correctly set, touch the strip where sensing was lost to reset the flag.

Automatic Method. If an automatic sense test method was used, the window also shows:

- The Amplitude Trend, a line graph of median weekly sense threshold measurements over time. The window displays the Trend if the A. or V. Amplitude Monitoring parameter was On at any point prior to the programming session. The Trend displays the Sense Configuration setting programmed at the time the weekly sample was taken.

  NOTE: Only automatic, out-of-clinic measurements are saved in the Amplitude Trend. Measurements obtained during a programming session are noted in the trend with a green dot, but are not saved in memory.

Accessed From: Tests > Capture & Sense > Sense/Ventricle or Sense/Atrium button > This Session tab

Last Session

The Last Session window contains the results of the last recorded Sense Tests.

If the Automatic test method was used, the window also shows:

- The **Amplitude Trend**, a line graph of median weekly sense threshold measurements over time. The window displays the Trend if the Amplitude Monitoring parameter was On at any point prior to the programming session. The Trend displays the Sense Configuration setting programmed at the time the weekly sample was taken.

  NOTE: Only automatic, out-of-clinic measurements are saved in the Amplitude Trend. Measurements obtained during a programming session are noted in the trend with a green dot, but are not saved in memory.

Accessed From: Tests > Capture & Sense tab > Sense/Ventricle or Sense/Atrium button > Last Session tab

[15] When the Sensitivity setting (mV) is increased, the actual sensitivity of the device decreases. Thus, as the test progresses, the device becomes less able to sense intrinsic activity.

Test Options

From the Options window, select a method to determine sense threshold. The options are:

- **Automatic**, which automatically measures the signal amplitude and stores an appropriate Sensitivity setting for later programming
- **Increment**, which manually measures the signal amplitude
- **Number of Cycles/Step**. If the Increment button is selected, this parameter determines how many paced and sensed cycles the programmer counts before it increases the Sensitivity setting to the next step[16].

Accessed From: Tests > Capture & Sense > Sense/Ventricle or Sense/Atrium button > Test Settings tab > Options button

Additional Parameters

The Additional Parameters window temporarily sets other test parameters. Permanently programmed parameter settings are restored when the test ends or is canceled.

Parameters that can be temporarily programmed include:

- Sense Configuration
- V. Refractory Period or A. Refractory Period (PVARP)
- Sensitivity
- Mode
- Base Rate
- Paced AV Delay
- Sensed AV Delay.

Accessed From: Tests > Capture & Sense > Sense/Ventricle or Sense/Atrium button > Test Settings tab > Additional Parameters button

AV Delays

The AV Delays window allows you to program the following parameters during the Sense Test:

- **Paced AV Delay**
- **Sensed AV Delay**

Accessed From: Tests > Capture & Sense tab > Sense-Ventricle or Sense-Atrium button > Perform Test tab > Paced/Sensed AV Delay "…" button

Battery & Leads

The Battery & Leads window contains:

- **Estimated longevity data**, including battery current, battery impedance, and Magnet Rate.
- **Lead data**, including the most recent lead impedance calculations, and the amplitude, current, and configuration of the pulse. Each Leads Impedance button opens the A. or V. Lead Impedance window to view yearly Lead Impedance trends.
- **Update Leads** button, which re-measures battery and leads data.

Accessed From: Tests > Battery & Leads

Magnet Rate

Magnet Rate (sometimes known as the Battery Test Rate) corresponds to the device's battery voltage and is an indicator of service life. As battery power is depleted, the Magnet Rate gradually declines from Beginning-of-Life (BOL) at 98.6 $\mathbf{min^{-1}}$ to approximately 86.3 $\mathbf{min^{-1}}$, which indicates Elective Replacement Indicator (ERI). Magnet Rates at 66 $\mathbf{min^{-1}}$ indicate End-of-Life. The table below lists representative Magnet Rates and the approximate corresponding battery voltage.

Table 8. Magnet rates between BOL and EOL and corresponding battery voltage values[17]

Magnet Rate ($\mathbf{min^{-1}}$)	Voltage
98.6 (BOL)	≥ 2.75
96.0	≥ 2.71
93.7	≥ 2.66
91.5	≥ 2.61
89.3	≥ 2.57
87.3	≥ 2.52
86.3 (ERI)	≥ 2.50
84.4	≥ 2.46
82.6	≥ 2.44
80.9	≥ 2.41
79.2	≥ 2.39
77.6	≥ 2.37

[16] When the Sensitivity setting (mV) is increased, the actual sensitivity of the device decreases. Thus, as the test progresses, the device becomes less able to sense intrinsic activity.
[17] Not all Magnet Rates are shown

Table 8. Magnet rates between BOL and EOL and corresponding battery voltage values[17]

Magnet Rate (min^{-1})	Voltage
76.1	≥ 2.34
74.6	≥ 2.32
73.2	≥ 2.30
71.8	≥ 2.28
70.5	≥ 2.27
69.2	≥2.23

Lead Impedance

The Lead Impedance window contains the:

- **1-Year Impedance Trend**, a line graph of median weekly lead impedance measurements over time. The window displays the Trend if the Lead Monitoring Parameter was programmed to the Monitor or Polarity Switch settings at any point prior to the programming session.
- **Lead Monitoring** parameter button, which reports the settings for the Lead Monitoring Parameter and opens the Leads parameters programming window.
- **Update Values** and **Print** buttons.

Accessed From: Tests > Battery & Leads > A. or V. Lead Impedance buttons

NOTE: Only automatic, out-of-clinic measurements are saved in the 1-Year Impedance Trend. Measurements obtained during a programming session are noted in the trend with a green dot, but are not saved in memory.

Sensor

The Sensor window contains one or two buttons:

- **The Reset Auto Threshold** button. This is a programmer-guided procedure to clear and recalculate the **Measured Average Sensor** data, which are used for setting automatic Threshold settings. Measured Average Sensor data are derived from the patient's activity level over the previous 18-hour period. See the Reset Auto Threshold instructions below (page 28).
- **Rate Response Optimization**. This is a programmer-guided procedure to change the Sensor parameter settings to achieve an optimal rate response to the patient's activity. The procedure collects data on the patient's exercise response and provides a graphic view of the effects of the revised Sensor parameter settings. See the Rate Response Optimization instructions below (page 28).

Available In: Sustain™ XL DR, SR; Victory™; Zephyr™ Devices

Accessed From: Tests > Sensor

Reset Auto Threshold

1. Select the Tests button.
2. Select the Sensor tab.
3. Select the Reset Auto Threshold button.
4. Have the patient rest quietly for the duration of the procedure or approximately 30 s.
5. Select the Start Procedure button.

   As the programmer clears the activity data from the device, the screen shows a countdown for approximately 30 s. The Done button appears when the procedure is complete.
6. Select the Done button.

Rate Response Optimization

1. From the Tests > Sensor window, select the Perform Test button.

   NOTE: The Rate Response Optimization procedure clears the stored Episodes from the device. You will not be able to run this procedure until you have read the Episodes. You will be able to print the episodes after the procedure. See Episodes (page 9).
2. Select the Start Test button.

   The programmer temporarily turns off Episode storage and clears the device's Episodes.
3. Remove the wand from the patient. Have the patient perform normal exercise, such as walking the hallway for two to ten minutes.
4. When the patient has completed the exercise, replace the wand on the patient and select the Stop Test button.

   The programmer restores previously programmed settings (including Episode storage) and shows the Rate Response Optimization Results window.
5. To view how a different setting would change the exercise response, select any of the rate response parameter buttons on the right side.

The “modeled” line on the graph indicates how the new settings would change the device’s rate response.

6. When you are satisfied with any new settings, select the Program button. Otherwise, select the Clear Selected button. Select the Print button to print the results.

Rate Response Optimization: Start Test

Rate Response Optimization (RRO) is a programmer-guided procedure to collect data on the patient’s exercise response and view the effects of various Sensor parameter settings on the device’s rate response.

NOTE: The Rate Response Optimization procedure clears the stored Episodes from the device. You will not be able to run this procedure until you have read the Episodes. You will be able to print the episodes after the procedure. See Episodes (page 9).

This screen shows two buttons:

- The **Cancel** button.
- The **Start Test** button. Select this to temporarily reprogram the device to turn off Episode collection and to collect activity data while the patient exercises.

Accessed From: Tests > Sensor > Rate Response Optimization Perform Test button

Rate Response Optimization: Programming

The programmer is temporarily programming the device’s data collection parameters to enable it to collect activity sensor data.

Accessed From: Tests > Sensor > Rate Response Optimization Perform Test button

Rate Response Optimization: Exercise

The programmer is waiting for the patient to perform some physical activity, such as walking a hallway.

When you press the Stop Test button, the programmer collects the activity data and creates a graph of the rates.

Episode collection is restored.

If no data are collected, you will be asked to restart the test.

Accessed From: Tests > Sensor > Rate Response Optimization Perform Test button

Rate Response Optimization: Retrieving Data

The programmer is creating the rate response model from the activity data collected.

Accessed From: Tests > Sensor > Rate Response Optimization Perform Test button

Rate Response Optimization: Results

The Rate Response Optimization Results window provides a graphic view of the effects of revised Sensor parameter settings on the device’s rate response to the patient’s exercise. Use this tool to change the Sensor parameter settings to achieve the optimal rate response. The window contains two panels:

- **Sensor Parameter Settings**. This panel lists each parameter, the settings used during the test (Tested), and buttons to change the parameter settings to view how the response could be optimized (Modeled). Whenever the settings in the Modeled column differ from the Tested column, a green line appears on the Rate Response Model to illustrate the effect on the patient’s pacing rate.
- **Rate Response Model**. This graph can contain up to three lines:
  - Blue. Illustrates how the patient’s pacing rate changed during exercise at the currently programmed Sensor parameter settings.
  - Red. Illustrates the measured intrinsic rate during the test.
  - Green. Illustrates how the patient’s pacing rate would respond if the Modeled parameter settings had been in effect.

See instructions for Rate Response Optimization (page 29).

Accessed From: Tests > Sensor > Rate Response Optimization Perform Test button

No Usable Rate Response Data Collected

The programmer was unable to detect any usable data from the previous exercise step. When you select the “Restart Test” button, the programmer prompts you to collect exercise data.

Cancel Rate Response Optimization

Please confirm that you want to cancel the test and restore the permanent programmed settings. If you select the Resume Test button, the exercise data is not lost.

Invalid Rate Response Parameters

An error has occurred that has resulted in an invalid setting for a rate response parameter. When you select the Close button, the Rate Response Optimization Results window is shown without any data. Restart the test.

QuickOpt™ Timing Optimization

The QuickOpt™ Timing Optimization window allows you to optimize the settings for the Paced AV Delay and Sensed AV Delay parameters based on the width of the atrial sense signal. The optimization procedure is only available in DDD mode.

The window contains two active buttons:

- **Perform Test.** This opens the QuickOpt Optimization Wizard to automatically measure the width of the atrial sense signal and propose new Delay settings.

- **Manual Testing & Results.** This button opens the QuickOpt Timing Cycle Optimization window and any previous optimization results.

Available In: Zephyr DR Devices

Accessed From: Tests > Timing Optimization tab

QuickOpt™ Optimization Wizard

This QuickOpt™ Timing Cycle Optimization Wizard window starts the automatic QuickOpt procedure. After you select the Start Test button, the programmer temporarily changes the Base Rate, Paced AV Delay, and Sensed AV Delay parameters[18]. The programmer restores the permanent settings after the measurements are complete.

The Cancel Test buttons returns you to the QuickOpt Timing Optimization window.

> NOTE: The QuickOpt Optimization results are saved on the programmer only for the duration of the session. Results are cleared at the end of the session.

See also: Instructions for the QuickOpt Optimization Manual Measurement (page 31).

Available In: Zephyr™ DR Devices

Accessed From: Tests > Timing Optimization tab > Perform Test button

Now Performing Measurements...

The programmer is now measuring the width of the atrial sense signals. The temporary settings on the dialog screen are now in effect. After measuring eight valid atrial sense signals, permanent settings are restored. The button in the window is:

- **Cancel Test.** Returns to the QuickOpt™ Timing Optimization window.

Optimization Measurements Successful

The programmer is now ready to program the optimal settings for Paced AV Delay and Sensed AV Delay.

The following check-boxes and buttons are shown in the window:

- Check-boxes:
  - **Sensed AV Delay.** Select this button to check (store for later programming) or un-check (leave the parameter unchanged) the proposed setting. To permanently program the setting, select the Program Optimal Values button below.
  - **Paced AV Delay.** Select this button to check (store for later programming) or un-check (leave the parameter unchanged) the proposed setting. To permanently program the setting, select the Program Optimal Values button below.
- Buttons:
  - **Done.** Closes this window without programming the Sensed AV Delay or Paced AV Delay parameters and returns to the QuickOpt™ Timing Optimization window.
  - **Print.** Prints a copy of the QuickOpt Optimization Freeze Capture.
  - **Program Optimal Values.** Permanently programs the optimized settings for the Sensed AV Delay or Paced AV Delay parameters. If the programming affects another parameter setting, the programmer displays the Preview Changes window.

Automatic Measurement Was Unsuccessful

The programmer was unable to obtain eight valid atrial sense signal measurements within 30 s of starting the procedure with the automatically programmed settings for the Base Rate, Paced AV Delay, and Sensed AV Delay parameters. To restart the measurement, select the parameter buttons to change the test settings to encourage atrial sensed signals, and then select the Continue button.

The Cancel Test button stops the measurements and opens the QuickOpt™ Timing Optimization window.

QuickOpt™ Timing Cycle Optimization

The QuickOpt™ Timing Cycle Optimization window contains controls to measure the width of the atrial sense signals and to optimize the device's settings for Paced AV Delay and Sensed AV Delay. The window contains the following buttons and check-boxes:

- **Perform Test: A Sense or A Sense xxx ms.** Select this button to open the manual A Sense measurement controls (QuickOpt Timing Cycle Optimization: A Sense). The button also shows any previous QuickOpt measurements.
- **EGM.** After the atrial sense signal was measured, select this button to open the QuickOpt™ Optimization Freeze Capture of the measurement.
- **Paced AV Delay:** Select this button to check (store for later programming) or un-check (leave the parameter unchanged) the proposed setting. To permanently program the setting, select the Program Optimal Values button below.
- **Sensed AV Delay:** Select this button to check (store for later programming) or un-check (leave the parameter unchanged) the proposed setting. To permanently program the setting, select the Program Optimal Values button below.
- **Program Optimal Values.** After a successful measurement, select this button to program the selected recommended settings.
- **Print Report.** After a successful measurement, select this button to print the results.

Available In: Zephyr™ DR Devices

Accessed From: Tests > Timing Optimization tab > Manual Testing & Results button

QuickOpt™ Timing Cycle Optimization: A Sense

The QuickOpt™ Timing Cycle Optimization: A Sense window shows:

[18] Other parameters that are temporarily disabled during measurement include Sensor, AF Suppression, and Negative AV/ PV Hysteresis.

- The **Start Test** button to begin measuring the width of the atrial sense signal. This toggles to the Stop Test button that appears after eight cycles have been measured.
- Additional buttons to **change relevant parameters** during the test.
- The **Cancel Temporary** button to cancel the temporary parameter settings.

See Instructions for the QuickOpt Optimization Manual Measurement (page 31).

Available In: Zephyr™ DR Devices

Accessed From: Tests > Timing Optimization tab > Manual Testing & Results button > Perform Test: A Sense button

Instructions for the QuickOpt™ Optimization Manual Measurement

1. From the Tests window, select the Timing Optimization tab.
2. Select the Manual Testing & Results button.

   The QuickOpt™ Timing Cycle Optimization window opens.
3. Select the Perform Test: A Sense button (if no measurement has been taken this session) or the A Sense xxx ms. button (if a previous measurement was taken this session).

   The QuickOpt Timing Cycle Optimization: A Sense window opens. Green buttons show temporarily programmed settings.
4. Select any available parameter button to temporarily change the setting during the test.

   To reveal the underlying rhythm, set low Base Rate and long Paced/Sensed AV Delay settings.
5. Select the Start Test button.

   The programmer institutes the temporary settings and begins to measure atrial sense signals. The procedure requires at least eight cycles to compute the optimal setting. The number of the measured cycles appears in the window. After eight cycles have been successfully measured, the Stop Test button is shown. The measurements continue until you select the Stop Test button.
6. After eight cycles, select the Stop Test button.

   The QuickOpt Timing Cycle Optimization window appears (see QuickOpt Timing Cycle Optimization (page 30)). You can either reject the proposed settings (Step 7) or accept them (Step 8).
7. To reject the suggested setting, uncheck the box next to the parameter and select the X at the top right corner of the screen to close the screen and return to the QuickOpt Timing Optimization window.
8. To accept any suggested setting, select the Paced AV Delay or Sensed AV Delay check-boxes. Then, select the Program Optimal Values button.

   If any other parameters are affected by this change, the Preview Changes window appears with all proposed changes.
9. Select the Program button to program the new settings or the Discard Changes button to reject the proposed changes.

QuickOpt™ Optimization Freeze Capture

The QuickOpt™ Freeze Optimization Capture window contains up to the most recent 30 s of the EGM, Markers data, and Surface ECG of the QuickOpt Optimization measurement. The window is formatted like any Freeze Capture, where you can change various aspects of the screen display and print the results. The window also contains the average measurement, the eight measurements used, and the optimal values for the Paced/Sensed AV Delay parameters.

Available In: Zephyr™ DR Devices

Accessed From: Tests > Timing Optimization tab > Manual Testing and Results button > Perform Test: A Sense button > Start Test> EGM button

Manual Measurement Was Unsuccessful

The settings used in the manual QuickOpt™ Timing Cycle Optimization could not successfully evoke eight valid atrial sense signals after the test was stopped. Press the Continue button to open the QuickOpt Timing Cycle Optimization window and change the test parameter settings. To help reveal the underlying rhythm, set low Base Rate and long Paced/Sensed AV Delay settings.

Alternatively, you can run the automatic test when you close the manual test window and select the Perform Test button from the Timing Optimization tab of the Tests window.

Measurements Were Unsuccessful

The programmer attempted to measure the atrial sense signals and was unsuccessful. To reveal the underlying rhythm, set low Base Rate and long Paced/Sensed AV Delay settings.

Select the Done button to navigate to the QuickOpt™ Timing Optimization window.

NIPS

See **NIPS and S1 Burst Test Instructions** (page 32)
- **NIPS Interaction with Other Parameters** (page 32)
- **NIPS Window** (page 32)
- **NIPS Test Parameters** (page 33)

The NIPS window allows you to conduct the Noninvasive Programmed Stimulation (NIPS) test for all available pacing chambers. NIPS uses the device's circuitry to introduce asynchronous electrical impulses to the myocardium at precise intervals in a predetermined pattern to reproduce and/or terminate a patient's clinical arrhythmia.

The NIPS window also allows you to conduct the S1 Burst test, which delivers continuous stimuli at the programmed S1 Cycle interval for as long as the S1 Burst button is selected.

Both tests require a continuous telemetry link during stimulation. Any telemetry break terminates the test and restores the permanently programmed parameters.

Accessed From: Tests > NIPS

WARNING: NIPS should be performed only by physicians trained in tachycardia induction and reversion protocols.

Cardiac resuscitation equipment should be available when you perform NIPS.

Risks associated with the use of this programmer for noninvasive electrophysiologic tests include the possibility of induction of fast or slow heart rates (which may cause light-headedness, shortness of breath, chest pains, and loss of consciousness) and the induction or exacerbation of tachyarrhythmias, which may require pharmacologic or electric shock intervention.

Establish a secure intravenous line before beginning NIPS to allow venous access in emergency situations.

Verify pacing capture thresholds before you conduct NIPS. Always maintain adequate safety margins when you choose output pulse settings.

If cardioversion or defibrillation is required, place the paddles in an anterior-posterior orientation or with an orientation perpendicular to the path between the heart and the device to reduce the potential of damage to the device's circuitry.

Verify the device's performance after defibrillation or cardioversion because of the potential for pacing system alterations, especially thresholds.

CAUTION: Ventricular Backup Pacing is delivered in the VOO Mode.

NIPS Interaction with Other Parameters

- **Elective Replacement Indicator (ERI).** NIPS is not available if the device is in ERI.
- **Pulse Amplitude**. During ventricular NIPS, output is at the currently programmed NIPS Pulse Amplitude and pulse rate settings.
- **V. AutoCapture™ Pacing System.** If the V. AutoCapture Pacing System is On, it is temporarily disabled during NIPS.
- **V. AutoCapture Off.** In Atrial NIPS, when the V. AutoCapture parameter is programmed Off, ventricular backup pacing is the permanently programmed V. Pulse Width and V. Pulse Amplitude settings.
- **V. AutoCapture On.** In Atrial NIPS, when the V. AutoCapture parameter is On, the V. Pulse Amplitude setting for ventricular backup pacing is programmed to either 3.5 or 4.5 V (depending on the last measured capture threshold) and to the permanently programmed V. Pulse Width setting.

NIPS and S1 Burst Test Instructions

NOTE: To print out the currently programmed NIPS parameters, select the Print Settings button.

NIPS

1. Place the telemetry wand over the device.
2. Select the Tests button.
3. Select the NIPS tab.
4. Select the Atrial or Ventricular NIPS button.

   The NIPS test screen appears.
5. Select the NIPS radio button and set the Coupling Interval, S1 Count, S1 Cycle length, and S2 through S4 Cycle length parameters.
6. To program additional parameters, select the Test Parameters button.
7. Select the Start NIPS button.

   The pulse train for the programmed S1 Count begins. The pulse train is canceled if the telemetry link is broken.

S1 Burst

1. Place the telemetry wand over the device.
2. Select the Tests button.
3. Select the NIPS tab.
4. Select the Atrial or Ventricular NIPS button.

   The NIPS test screen appears.
5. Select the S1 Burst radio button and set the Coupling Interval and the S1 Cycle length parameters.
6. Press and hold the S1 Burst button for the desired duration.

   The programmer shows the duration of the S1 Burst.
7. Release the S1 Burst button when the test is complete.

NIPS Window

See NIPS and S1 Burst Test Instructions (page 32).

From the NIPS window:

- Choose the type of NIPS test to conduct (NIPS or S1 Burst).
- Set additional test options with the NIPS Test Parameters button.
- Print the current NIPS Test Parameters with the Print Settings button.
- Run the test.
- Set the NIPS Test Parameters, including:
  - Coupling Interval
  - S1 Count
  - S1 Cycle
  - S2 Cycle
  - S3 Cycle
  - S4 Cycle

Accessed From: Tests > NIPS > Atrial or Ventricular NIPS

Coupling Interval

The Coupling Interval parameter determines the interval between the last paced or sensed event and the first delivered S1 stimulus. When the device is programmed to DDD(R) or DDI(R) modes, the shortest available coupling interval during NIPS is equal to the larger of the Paced AV Delay or Sensed AV Delay settings plus 30 ms.

Settings: (ms) 100 – 800 in steps of 10 (Nominal: 500)

Accessed From: Tests > NIPS > Atrial or Ventricular NIPS

S1 Count

The S1 Count parameter sets the number of stimuli delivered in the S1 drive train. The first stimulus is delivered after the programmed coupling interval.

Settings: 1 – 25 in steps of 1 (Nominal: 8)

Accessed From: Tests > NIPS > Atrial or Ventricular NIPS

S1 Cycle

The S1 Cycle parameter is the length of the paced cycle between the S1 stimuli.

Settings: (ms) Off; 100 – 800 in steps of 10 (Nominal: Off)

Accessed From: Tests > NIPS > Atrial or Ventricular NIPS

S2 Cycle

The S2 Cycle parameter is the length of the paced cycle following delivery of the S1 drive train.

Settings: (ms) Off; 100 – 800 in steps of 10 (Nominal: Off)

Accessed From: Tests > NIPS > Atrial or Ventricular NIPS

S3 Cycle

The S3 Cycle parameter is the length of the paced cycle following delivery of the S2 drive train.

Settings: (ms) Off; 100 – 800 in steps of 10 (Nominal: Off)

Accessed From: Tests > NIPS > Atrial or Ventricular NIPS

S4 Cycle

The S4 Cycle parameter is the length of the paced cycle following delivery of the S3 drive train.

Settings: (ms) Off; 100 – 800 in steps of 10 (Nominal: Off)

Accessed From: Tests > NIPS > Atrial or Ventricular NIPS

NIPS Test Parameters

See NIPS and S1 Burst Test Instructions (page 32).

The NIPS Test Parameters window allows you to set the following NIPS parameters:

- V. Backup Rate
- Pulse Amplitude
- Pulse Width
- Pulse Configuration
- Sinus Node Recovery Delay (SNRD)

V. Backup Rate

The V. Backup Rate parameter is the pacing rate of the stimulus delivered to the ventricle during A. NIPS (VOO pacing). During the delivery of atrial NIPS, the V. Pulse Amplitude and V. Pulse Width parameters of the backup pacing are set at the current programmed settings.

Settings: (min^{-1}) Off; 30; 40 – 95 in steps of 5 (50)

Accessed From: Tests > NIPS > Atrial NIPS > Test Parameters

Pulse Amplitude

The NIPS Pulse Amplitude parameter is the amount of voltage delivered to the myocardium during NIPS testing. It is independent of the current programmed setting for the Pulse Amplitude parameter.

Settings: (V) 0.0 – 4.0 in steps of 0.25; 4.5 – 7.5 in steps of 0.5 (Nominal: 3.5)

Accessed From: Tests > NIPS > Atrial or Ventricular NIPS > Test Parameters

Pulse Width

The NIPS Pulse Width parameter is the duration of the pulse during NIPS testing. It is independent of the current programmed setting for the Pulse Width parameter.

Settings: (ms) 0.05; 0.1 – 1.5 in steps of 0.1 (Nominal: 0.4)

Accessed From: Tests > NIPS > Atrial or Ventricular NIPS > Test Parameters

Pulse Configuration

The NIPS Pulse Configuration parameter sets the anode and cathode of the pulse during NIPS testing. The NIPS setting for this parameter is independent of the current programmed setting for the Pulse Configuration parameter.

Settings: Unipolar (tip–case); Bipolar (tip–ring) (Nominal: Unipolar)

Accessed From: Tests > NIPS > Atrial or Ventricular NIPS > Test Parameters

Sinus Node Recovery Delay (SNRD)

The Sinus Node Recovery Delay parameter is the time allowed between the final atrial NIPS pulse and the resumption of normal atrial pacing. This delay provides a period with no external stimulation to allow time for the sinus node to recover from the stimuli.

Settings: (s) 1 – 5 in steps of 1 (Nominal: 1)

Accessed From: Tests > NIPS > Atrial or Ventricular NIPS > Test Parameters

Temporary Pacing

Use this screen to temporarily program selected parameters. After you choose a different parameter setting, select the Start Temporary button to initiate the temporary settings. You can change a temporarily programmed setting or add additional temporary settings during temporary pacing.

When you are ready to restore permanent settings, select the Cancel Temporary button or select another screen.

Select the Discard Changes button to reset all settings to their permanently programmed values.

Brady Parameters

The Brady Parameters window shows most of the programmable brady parameters divided into groups. Select the appropriate button to change parameter settings. The buttons are:

- **Basic Operation** (page 35)
- **Rates** (page 11)
- **Delays** (page 39)
- **Capture & Sense** (page 42)
- **Leads** (page 45)
- **Refractories & Blanking** (page 47)
- **AT/AF Detection & Response** (page 52)

Accessed From: Parameters button > Brady tab

Basic Operation

From the Basic Operation window, you can change the settings for the following parameters:

- Mode (page 35)
- Magnet Response (page 35)
- Sensor (page 36)
- Threshold (page 36)
- Slope (page 36)
- Max Sensor Rate (page 37)
- Reaction Time (page 37)
- Recovery Time (page 37)

Accessed From: Parameters button > Brady tab > Basic Operation button

Mode

The Mode parameter determines the basic operation of the device.

For timing diagrams and mode description, see Mode Descriptions (page 61)

Accessed From: Parameters button > Brady tab > Basic Operation button

Magnet Response

The Magnet Response parameter determines how the device responds when a magnet is placed over it. The settings are Off (no response) and Battery Test, which causes the device to pace asynchronously at the Magnet Rate, an indication of battery status. When the magnet is removed, the pacing rate returns to the programmed Base Rate or Sensor-indicated rate.

The programmer shows the magnet rate in the Battery & Leads window.

See Magnet Rate (page 27).

Settings: Off; Battery Test (Nominal: Battery Test)

Accessed From: Parameters button > Brady tab > Basic Operation button

NOTE: **Interactions with Algorithms.** When the Magnet Response parameter is programmed to the Battery Test setting, telemetry is disabled when a magnet is held over the device and the following functions are temporarily suspended (they are restored when the magnet is removed):

- V. AutoCapture™ Pacing System algorithms
- Rest Rate and Hysteresis Rate
- Rate-modulated pacing
- PVC Options
- PMT Options
- AutoIntrinsic Conduction Search or V. Intrinsic Preference (VIP™)
- Auto Mode Switch
- AF Suppression™ Parameter Algorithm
- AT/AF Detection

The following functions are canceled while a magnet is held over the device (if the Magnet Response parameter is programmed to the Battery Test setting):

- NIPS
- Reset Auto Threshold
- Any Temporary Programming
- Advanced Hysteresis Functions
- Battery & Leads status collection

Paced AV Delay. In dual-chamber modes, the Paced AV Delay parameter is temporarily programmed to 120 ms during magnet application.

Elective Replacement Indicator (ERI). At ERI, the Magnet Response parameter is automatically programmed to the Battery Test setting.

V. AutoCapture. When the V. AutoCapture parameter is On and the Magnet Response parameter is set to the Battery Test setting, a magnet application switches the device to High Output Mode. If you remove the magnet, the device restores previously programmed settings and begins a Threshold Search.

Episode Triggers. If the Magnet Placement Trigger parameter is programmed On and the Magnet Response parameter is set to the Battery Test setting, the device stores the episode after a two-second delay and performs a Battery Test after a five-second delay.

Sensor

The Sensor parameter turns on rate-responsive pacing, which enables the device to increase or decrease its rate based on activity sensor data.

In the Passive setting, the device does not activate rate-responsive pacing, but it records diagnostic data that can be read in the Rates.

Available In: Sustain™ XL DR, SR; Victory™; Zephyr™ Devices

Settings: On; Off; Passive (Nominal: Passive)

Accessed From: Parameters button > Brady tab > Basic Operation button

NOTE: **Elective Replacement Indicator (ERI).** When the device reaches ERI, it automatically reprograms Sensor to Off, which disables rate-modulated pacing.

ODO, OVO, and OAO Modes are not available when Sensor is programmed On.

Threshold

The Threshold parameter is the "trigger point" at which a certain level of activity affects the Sensor-indicated rate. A lower Threshold setting allows the sensor to respond to lower levels of activity, while a higher setting makes the sensor respond only to higher activity levels.

"Auto" settings automatically adjust the Threshold parameter above or below the Measured Average Sensor (MAS) value, a calculation of the patient's activity over the previous 18 hours. Thus, a setting of Auto (+1.0) automatically sets the Threshold parameter to 3.0 if the MAS value is 2.0. The MAS value is continually updated with new sensor data.

The MAS value appears under the Threshold button in the Basic Operation window.

To clear and recalculate the MAS value, select the Reset Auto Threshold button on the Tests > Sensors window.

Available In: Sustain™ XL DR, SR; Victory™; Zephyr™ Devices

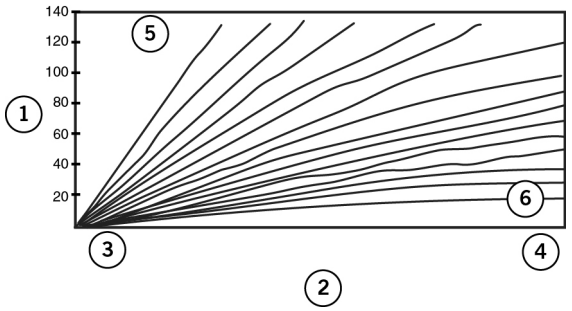
Settings: Auto (-0.5); Auto (+0.0); Auto (+0.5); Auto (+1.0); Auto (+1.5); Auto (+2.0); 1 – 7 in steps of 0.5 (Nominal: Auto+0.0)

Accessed From: Parameters button > Brady tab > Basic Operation button

Slope

The Slope parameter assigns a flatter (low setting) or steeper (high setting) slope to the sensor rate-response. Lower settings, or flatter responses, limit the response to activity to small increases in the pacing rate. Higher settings, or steeper responses, allow the rate to increase to higher pacing rates. The figure below illustrates the various settings for the Slope parameter.

Figure 8. Slope



1. Increase in Rate (min^{-1})
2. Sensor Level
3. Low Activity
4. High Activity
5. Slope 16
6. Slope 1

"Auto" settings automatically adjust the Slope parameter above or below a calculation of the patient's activity over the previous seven days, the Auto Slope. Thus, a setting of Auto (+1.0) automatically sets the Slope parameter to 14 if the Auto Slope is 13.

The Auto Slope value is shown under the Slope button in the Basic Operation window.

Available In: Sustain™ XL DR, SR; Victory™; Zephyr™ Devices

Settings: Auto (-1); Auto (+0); Auto (+1); Auto (+2); Auto (+3); 1 – 16 (Nominal: Auto (+2)

Accessed From: Parameters button > Brady tab > Basic Operation button

Max Sensor Rate

The Max Sensor Rate (MSR) parameter is the highest pacing rate allowed by rate-modulated pacing. It is also the highest Sensor-indicated rate that can be recorded in the Passive setting.

Available In: Sustain™ XL DR, SR; Victory™; Zephyr™ Devices

Settings: (min^{-1}) 80 – 150 in steps of 5; 160 – 180 in steps of 10 (Nominal: 130)

Accessed From: Parameters button > Brady tab > Basic Operation button

NOTE: **AF Suppression™ Parameter.** This function is controlled by the Maximum AF Suppression Rate parameter.

Interactions with Algorithms. The interaction of a number of algorithms may allow the device to override Max Track Rate and MSR. These include AF Suppression, V. AutoCapture™, AutoIntrinsic Conduction Search, Negative AV Hysteresis with Search, V. Safety Standby, V. Intrinsic Preference (VIP™), and all ventricular-based algorithms. This interaction is more likely to occur in cases where operational Paced AV Delay is significantly different than the patient's conduction time. For more information on upper rate behavior, contact Technical Support (page 69).

Reaction Time

The Reaction Time parameter controls how quickly increases in the Sensor-indicated rate occur. A Very Fast setting allows for rapid rate increases, while a Slow setting only allows the rate to increase slowly.

Available In: Sustain™ XL DR, SR; Victory™; Zephyr™ Devices

Settings: Very Fast; Fast; Medium; Slow (Nominal: Fast)

Accessed From: Parameters button > Brady tab > Basic Operation button

NOTE: **Slope.** Reaction Time increases are limited by the Slope setting.

Tracking and Triggered Operation are not affected by the setting for Reaction Time.

Recovery Time

The Recovery Time parameter controls how quickly decreases in the Sensor-indicated rate occur. A Fast setting allows for rapid rate decreases, while a Very Slow setting only allows the rate to decrease slowly.

Available In: Sustain™ XL DR, SR; Victory™; Zephyr™ Devices

Settings: Fast; Medium; Slow; Very Slow (Nominal: Medium)

Accessed From: Parameters button > Brady tab > Basic Operation button

NOTE: **Slope.** Recovery Time increases are limited by the Slope setting.

Tracking and Triggered Operation are not affected by the setting for Recovery Time.

Rates

From the Rates window, you can change the settings for the following parameters:

- Base Rate (page 37)
- Rest Rate (page 37)
- Max Sensor Rate (page 37)
- Max Track Rate (page 38)
- Hysteresis Rate (page 38)
- Search Interval (page 39)
- Cycle Count (page 39)
- Intervention Rate (page 39)
- Intervention Duration (page 39)
- Recovery Time (page 39)

Accessed From: Parameters button > Brady tab > Rates button

Base Rate

The Base Rate parameter sets the patient's minimum pacing rate. Typically, rates can fall lower than the Base Rate setting only if Rest Rate or Hysteresis Rate is programmed.

In atrial modes, the Base Rate interval is measured from an atrial stimulus to the next atrial stimulus without an intervening sensed atrial event. In ventricular modes, the interval is from a ventricular stimulus to the next stimulus without an intervening sensed ventricular event.

Settings: (min^{-1}) 30; 40 – 130 in steps of 5; 130 – 170 in steps of 10 (Nominal: 60)

Accessed From: Parameters button > Brady tab > Rates button

NOTE: **Elective Replacement Indicator (ERI).** When battery voltage decreases to ERI, the actual pacing interval is 100 ms longer than the programmed Base Rate interval. Programmed versus actual pacing rates for Base Rate at ERI are shown in this table (page 73).

Rest Rate

The Rest Rate parameter allows the device to decrease its pacing rate to a rate below the Base Rate setting while the patient is asleep or in long periods of rest.

When the Rest Rate parameter is programmed, the device analyzes activity data over a seven-day period. When it detects that the patient has been inactive for more than 15 to 20 minutes, it switches the pacing rate from the Base Rate setting to the Rest Rate setting.

When the device senses activity, pacing is resumed at the Base Rate setting or at the Sensor-indicated rate.

Available In: Sustain™ XL DR, SR; Victory™; Zephyr™ Devices

Settings: (min^{-1}) Off; 30 – 130 in steps of 5; 140; 150 (Nominal: Off)

Accessed From: Parameters button > Brady tab > Rates button

NOTE: **Post-implant.** Do not program Rest Rate until at least seven days following implantation in order to collect reliable activity data.

Testing. The Rest Rate parameter is temporarily turned Off during a V. Capture Test, a V. AutoCapture™ Setup, an ACap™ Confirm Setup, an A. Capture Test, and NIPS.

Hysteresis Rate is disabled when Rest Rate is operating.

Mode Switch. While the device is operating at the AMS Base Rate, the Rest Rate parameter operates at the Base Rate setting.

Max Track Rate

The Max Track Rate (MTR) parameter is the maximum ventricular pacing rate allowed by the device. If the device in DDD(R) mode senses an atrial rhythm faster than the MTR setting, the Sensed AV Delay is extended to ensure that the ventricular paced rate does not exceed the MTR setting. Occasional pauses (Wenckebach behavior) may occur in accord with normal upper rate behavior.

As an aid to programming, when the MTR parameter is programmed, the programmer shows the intrinsic atrial rate at which 2:1 AV block occurs.

Available In: Sustain™ XL DR, DC; Victory™ DR; Zephyr™ DR Devices

Settings: (min^{-1}) 90 – 130 in steps of 5; 140 – 180 in steps of 10 (Nominal: 130)

Accessed From: Parameters button > Brady tab > Rates button

NOTE: **Max Sensor Rate.** The MTR can be exceeded if the Max Sensor Rate is programmed higher than the MTR.

Interactions with Algorithms. The interaction of a number of algorithms may allow the device to override MTR and Max Sensor Rate. These include AF Suppression™, V. AutoCapture™, AutoIntrinsic Conduction Search, Negative AV Hysteresis with Search, V. Safety Standby, V. Intrinsic Preference (VIP™), and all ventricular-based algorithms. This interaction is more likely to occur in cases where operational Paced AV Delay is significantly different than the patient's conduction time. For more information on upper rate behavior, contact Technical Support (page 69).

Hysteresis Rate

The Hysteresis Rate parameter is a rate below the Base Rate setting that is used when the patient's intrinsic rhythm is preferred to pacing. When the Hysteresis Rate parameter is programmed, the device decreases the pacing rate from the Base Rate setting to the Hysteresis Rate setting when it senses intrinsic activity. If the device fails to sense intrinsic activity, the device switches back to the Base Rate setting.

Operation at the Hysteresis Rate setting is triggered by a P-wave in atrial-based modes [DDD(R), VDD(R), AAI(R), AAT(R)] and an R-wave in ventricular-based modes [DDI(R), DVI(R), VVI(R), VVT(R)].

See Advanced Hysteresis Functions (page 38).

Settings: (min^{-1}) Off; 30 – 130 in steps of 5; 130 – 150 in steps of 10 (Nominal: Off)

Accessed From: Parameters button > Brady tab > Rates button

NOTE: **Rate-Modulated Modes.** Hysteresis Rate is disabled if the device detects sensor activity.

AF Suppression™ Parameter. Hysteresis Rate is autoprogrammed Off when AF Suppression™ is programmed On.

Rest Rate takes precedence over the Hysteresis Rate.

Hysteresis Tracking Rate

When VDD(R) mode is programmed, the Hysteresis Tracking Rate nonprogrammable parameter is the minimum intrinsic atrial rate at which P-waves can be tracked. This rate equals the currently programmed Hysteresis Rate interval and the Sensed AV Delay.

When VDD(R) mode is programmed, the Hysteresis Tracking Rate value appears on the programmer screen below the Hysteresis Rate button.

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Advanced Hysteresis Functions

Up to five additional parameters are available in some devices when the Hysteresis Rate parameter is enabled. The parameters include:

- Search Interval (page 39)
- Cycle Count (page 39)
- Intervention Rate (page 39)
- Intervention Duration (page 39)
- Recovery Time (page 39)

Search Interval

The Search Interval parameter tells the device to periodically extend the pacing interval by the programmed number of minutes to search for intrinsic activity. Thus, if you select "5," the device reduces the pacing rate to the Hysteresis Rate setting every five minutes to search for intrinsic activity.

If the device senses an intrinsic beat during the search, it reduces the rate to the programmed Hysteresis Rate setting. If no intrinsic beat is sensed during the Hysteresis Rate interval, the device delivers a pulse at the end of the interval and begins pacing at the Base Rate setting. If a native beat occurs between searches, the device operates at the Hysteresis Rate setting.

Settings: (min) Off; 5; 10; 15; 30 (Nominal: 5 min)

Accessed From: Parameters button > Brady tab > Rates button

> NOTE: AutoIntrinsic Conduction Search. When Search Interval is programmed, its setting is also used as the search frequency for AutoIntrinsic Conduction Search.

Cycle Count

Used in conjunction with Search Interval, the Cycle Count parameter is the number of cycles the device counts when it searches for intrinsic activity.

The Cycle Count parameter also determines the number of cycles that the patient's intrinsic rate may drop below the programmed Hysteresis Rate setting before the algorithm begins to pace at the Intervention Rate setting, when the Intervention Rate parameter is enabled.

Settings: (cycles) 1 – 16 (Nominal: 1)

Accessed From: Parameters button > Brady tab > Rates button

Intervention Rate

Use this function to "intervene" if the patient's intrinsic rate falls below the Hysteresis Rate setting and needs to be quickly restored to a higher pacing rate.

When the Intervention Rate parameter is enabled, the device begins pacing at the Intervention Rate setting when the pacing rate falls below the Hysteresis Rate setting for a period longer than the Cycle Count setting. The Intervention Rate setting stays in effect for the time set by the Intervention Duration parameter. The rate then returns to the Base Rate setting along a time line described by the Recovery Time parameter.

If the Intervention Rate parameter is programmed Off, the device paces at the programmed Base Rate setting if the intrinsic rate drops below the Hysteresis Rate setting.

Settings: (min^{-1}) Off; Base Rate; Intrinsic+0; Intrinsic+10; Intrinsic+20; Intrinsic+30; 80 – 120 in steps of 10 (Nominal: Off)

Accessed From: Parameters button > Brady tab > Rates button

> NOTE: **Episodes.** If the Intervention Rate parameter is enabled, it autoprograms the Advanced Hysteresis Trigger On in devices with that function.

Intervention Duration

The Intervention Duration parameter is the number of minutes that the device operates at the Intervention Rate setting. After this time period, the device decreases the rate according to the programmed Recovery Time parameter until the Base Rate setting or Sensor-indicated rate is reached and normal Hysteresis Rate operation resumes.

The Intervention Duration parameter is not programmable if the Intervention Rate parameter is Off.

Settings: (min) 1 – 10 (Nominal: 3)

Accessed From: Parameters button > Brady tab > Rates button

Recovery Time

The Recovery Time parameter determines how quickly the device reduces the pacing rate from the Intervention Rate setting to the Base Rate setting following an advanced hysteresis intervention. This parameter also operates with the Sensor parameter and can be changed from the Basic Operation window. However, the Sensor parameter does not have to be On to program the Recovery Time parameter.

The Recovery Time parameter button is not active in this window if the Intervention Rate parameter is Off.

Settings: Fast; Medium; Slow; Very Slow (Nominal: Medium)

Accessed From: Parameters button > Brady tab > Rates button

Delays

From the Delays window, you can change the settings for the following parameters:

- Paced AV Delay (page 40)
- Sensed AV Delay (page 40)
- Rate Responsive AV Delay (page 40)
- Shortest AV Delay (page 40)
- V. Intrinsic Preference (VIP™) (page 41)
- VIP Search Interval (page 41)
- VIP Search Cycles (page 41)
- Negative AV Hysteresis with Search (page 41)

Accessed From: Parameters button > Brady tab > Delays button

Paced AV Delay

The Paced AV Delay parameter is the interval between a paced atrial event and a ventricular pulse.

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: (ms) 25; 30 – 200 in steps of 10; 225 – 300 in steps of 25; 350 (Nominal: 200)

Accessed From: Parameters button > Brady tab > Delays button

NOTE: **Long Paced AV Delay.** Use caution if you program a Long Paced AV Delay or Sensed AV Delay because these parameters are extended by 100 ms after loss of capture when V. AutoCapture™ is programmed on. This extension reduces fusion-induced threshold searches[19].

Base Rate. The longest programmable Paced AV Delay is determined by the Base Rate setting. The maximum Paced and Sensed AV Delay settings for all programmed Base Rate settings are shown in the table below.

Table 9. Maximum Paced AV Delay and Sensed AV Delay settings for each Base Rate setting

Base Rate (**min^{-1}**)	Maximum Sensed/Paced AV Delay (ms)	Base Rate (**min^{-1}**)	Maximum Sensed/Paced AV Delay (ms)
30-85	350	110	200
90	300	115	170
95	275	120	150
100	250	125	130
105	225	≥ 130	120

Sensed AV Delay

The Sensed AV Delay parameter is the interval between a sensed atrial event and a ventricular pulse.

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: (ms) 25; 30 – 200 in steps of 10; 225 – 325 in steps of 25 (Nominal: 150)

Accessed From: Parameters button > Brady tab > Delays button

NOTE: **Long Sensed AV Delay.** Use caution if you program a Long Paced AV Delay or Sensed AV Delay because these parameters are extended by 100 ms after loss of capture when V. AutoCapture is programmed on. This extension reduces fusion-induced threshold searches[20].

Base Rate. The longest programmable Sensed AV Delay is determined by the Base Rate setting. The maximum Paced and Sensed AV Delay settings for all programmed Base Rate settings are shown in table above (page 40).

Rate Responsive AV Delay

The Rate Responsive AV Delay parameter increases or decreases the Paced AV Delay or Sensed AV Delay in relation to changes in the Sensor-indicated rate or sensed intrinsic atrial rate. A Low setting changes the Paced/Sensed AV Delay by one ms for each one-**min^{-1}** change in the Base Rate. A High setting changes the Paced/Sensed AV Delay by three ms for each one-**min^{-1}** change in the Base Rate. Thus as pacing rates rise, the device decreases both the Paced and Sensed AV Delay settings until the Max Sensor Rate, Max Track Rate, or Shortest AV Delay setting is reached.

The algorithm begins to operate when the rate exceeds either 90 **min^{-1}** or a Base Rate set above 90 **min^{-1}**. When the Sensor-indicated rate or sensed intrinsic atrial rate falls below 90 **min^{-1}**, the algorithm terminates.

Available In: Sustain™ XL DC, DR, SR; Victory™ DR; Zephyr™ DR Devices

Settings: Off; Low; Medium; High (Nominal: Off)

Accessed From: Parameters button > Brady tab > Delays button

NOTE: **Sensor.** The Rate Responsive AV Delay parameter is available at any Sensor setting.

FARI. The Rate Responsive AV Delay parameter is based on the Filtered Atrial Rate Interval (FARI) and does not change abruptly when Wenckebach upper rate behavior occurs. See Auto Mode Switch (page 52).

Shortest AV Delay

The Shortest AV Delay parameter defines the minimum AV Delay for the Rate Responsive AV Delay and Negative AV Hysteresis with Search settings.

Available In: Sustain™ XL DC, DR, SR; Victory™ DR; Zephyr™ DR Devices

Settings: (ms) 30[21] – 50 in steps of 5; 60 – 120 in steps of 10 (Nominal: 100)

Accessed From: Parameters button > Brady tab > Delays button

NOTE: **Elective Replacement Indicator (ERI).** When the device reaches ERI, the Shortest AV Delay parameter is automatically programmed to 70 ms.

[19] In Sustain XL DC, DR, Victory DR and Zephyr DR devices, the Paced AV Delay is limited to 350 ms.
[20] In Sustain XL DC, DR, Victory DR and Zephyr DR devices, the Paced AV Delay is limited to 350 ms.
[21] Although 30 ms can be programmed, actual Sensed AV Delay settings cannot fall below 40 ms. Actual Paced AV Delay settings can reach 30 ms.

V. Intrinsic Preference (VIP™)

The V. Intrinsic Preference (VIP™) parameter periodically extends the device's ventricular alert period (that is, the Paced/Sensed AV Delay parameter) for ventricular events so that the device can reduce ventricular pacing.

The setting for the VIP parameter equals the amount of extension of the Paced/Sensed AV Delay parameter. For example, if the Paced/Sensed AV Delay parameter is set at 150 ms and the VIP parameter is set at 50 ms, then the device periodically sets its total AV Delay at 200 ms. If the device senses intrinsic conduction in this longer alert period, the algorithm maintains the extended AV Delay until it no longer detects an intrinsic beat.

Before the device reverts back to the programmed Paced/Sensed AV Delay, it must fail to detect intrinsic conduction for the number of cycles specified by the VIP Search Cycles parameter.

If the device fails to find intrinsic rhythm, it begins a new search at the interval specified by the VIP Search Interval parameter.

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: (ms): Off; 50; 75; 100; 125; 150; 160; 170; 180; 190; 200 (Nominal: Off)

Accessed From: Parameters button > Brady tab > Delays button

NOTE: **High Base Rate.** The VIP parameter does not operate when the Base Rate parameter is set to ≥ 110 min^{-1}.

PVCs have no effect on this feature.

V. AutoCapture™. If the VIP parameter is enabled and the V. AutoCapture parameter is programmed On, the VIP setting is autoprogrammed to a minimum of 100 ms[22].

Paced/Sensed AV Delay. The combined settings for the VIP and Paced/Sensed AV Delay cannot exceed 455 ms.

Consecutive R-waves. When three consecutive R-waves occur within the Paced/Sensed AV Delay setting, the VIP algorithm extends the Paced/Sensed AV Delay by the value of the VIP setting.

The following situations disable the VIP parameter:

- If the Mode is DDD(R) or VDD(R) and the Base Rate is ≥ 110 min^{-1}
- If the atrial rate or atrial paced rate is ≥ 110 min^{-1}
- If the Negative AV Hysteresis with Search parameter is enabled
- If the Advanced Hysteresis Functions are initiated
- If a magnet is applied.

VIP™ Search Interval

The Search Interval parameter sets how often the device searches for intrinsic conduction when the V. Intrinsic Preference (VIP™) parameter is enabled.

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: 30 s; 1 min; 3 min; 5 min; 10 min; 30 min (Nominal: 1 min)

Accessed From: Parameters button > Brady tab > Delays button

VIP™ Search Cycles

The Search Cycles parameter sets how many cycles the Paced/Sensed AV Delay extension remains in effect while searching for intrinsic conduction when the V. Intrinsic Preference (VIP™) parameter is enabled.

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: (cycles) 1; 2; 3 (Nominal: 1)

Accessed From: Parameters button > Brady tab > Delays button

Negative AV Hysteresis with Search

The Negative AV Hysteresis with Search parameter enables the device to decrease the Paced AV Delay and Sensed AV Delay whenever an R-wave is detected in order to discourage intrinsic conduction and encourage ventricular pacing. The settings are the amount the Paced/Sensed AV Delay is decreased after an R-wave detection.

When Negative AV Hysteresis with Search is enabled, a detected R-wave shortens the Paced/Sensed AV Delay. This remains in effect for 32 cycles after R-wave detection. If another R-wave is not detected in that time, the permanently programmed Paced/Sensed AV Delay is restored. If another R-wave is detected during the 32-cycle period, the shortened Paced/Sensed AV Delay remains in effect for 256 cycles.

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: (ms) Off; -10 to -110 in steps of 10 (Nominal: Off)

Accessed From: Parameters button > Brady tab > Delays button

NOTE: **Sensor.** Sensor-driven increases in the pacing rate or Rate Responsive AV Delay can override or further shorten the Paced/Sensed AV Delay beyond the setting for Negative AV Hysteresis with Search.

Shortest AV Delay. Negative AV Hysteresis with Search cannot reduce the Paced/Sensed AV Delay to a setting below the Shortest AV Delay.

[22] If VIP is set to ≥ 100 ms, programming V. AutoCapture On does not change the VIP setting.

V. AutoCapture™. When V. AutoCapture is programmed On, Negative AV Hysteresis with Search is suspended after two consecutive capture losses. The algorithm resumes when capture is restored. When Negative AV Hysteresis with Search is programmed, it cancels the 100 ms Paced/Sensed AV Delay extension after loss of capture.

AutoIntrinsic Conduction Search (AICS) or **V. Intrinsic Preference (VIP™).** Negative AV Hysteresis cannot be turned on if AICS or VIP is enabled.

Capture & Sense

From the Capture & Sense window, you can change the settings for the following parameters:

- ACap™ Confirm Parameter (Zephyr™ DR devices only) (page 42)
- V. AutoCapture (page 43)
- Pulse Amplitude (page 44)
- Pulse Width (page 44)
- Amplitude Monitoring (page 44)
- Sensitivity (page 44)
- Backup Pulse Configuration (page 44)
- Automatic Capture Settings Window (page 45)

Accessed From: Parameters button > Brady tab > Capture & Sense button

ACap™ Confirm Parameter

The ACap™ Confirm parameter periodically measures the atrial capture threshold and automatically sets the A. Pulse Amplitude setting above the measured threshold. The table below shows the amount of the additional voltage above the measured threshold that the ACap Confirm function adds to the atrial capture threshold.

The device measures the capture threshold when the automatic A. Capture Test is conducted and every eight or 24 hours, depending on the setting of the Search Frequency parameter (accessed from the Automatic Capture Settings Window on the Capture & Sense parameters window).

The ACap Confirm parameter has three settings:

- **On.** The device measures the threshold, automatically adjusts the A. Pulse Amplitude setting, and records the threshold measurement in the Threshold Trend (This Session) and the Follow-up EGM.
- **Monitor.** The device only measures and records the A. capture threshold in the Threshold Trend but does not adjust the A. Pulse Amplitude setting.
- **Off.** The device does not measure or record the capture threshold and does not automatically adjust the A. Pulse Amplitude setting.

  NOTE: To ensure the pacing system can operate the ACap Confirm function, conduct the ACap Confirm Setup test before programming the ACap Confirm parameter to On or Monitor.

Table 10. Amount of Pulse Amplitude increase over the measured atrial capture threshold

Atrial Capture Threshold (V)[23]	Additional Amplitude (V)
≥ 1.5	1.0[24]
1.625 - 2.25	1.5
2.375 - 3.0	2.0
3.125 - 3.875	Fixed at 5.0 V

To operate the ACap Confirm function, you must:

- Implant a low polarization, bipolar pacing lead in the atrium.
- Set the A. Lead Type parameter to Uni/Bi or Bipolar.
- Set the A. Pulse Configuration parameter to Bipolar.
- Run the ACap Confirm Setup.

When the ACap Confirm parameter is programmed to the On or Monitor settings, a number of programming changes occur:

- The programmer shows the A. Automatic Pulse Amplitude and additional ACap Confirm parameters; A. Pulse Amplitude becomes unavailable.
- The programmer resets the A. Backup Pulse Configuration and A. Search Frequency parameters for later programming.
- The programmer resets the A. Pulse Configuration setting to Bipolar for later programming (if it is set to Unipolar).
- The Automatic Pulse Amplitude parameter is set to the last measured capture threshold plus the amount listed in the table above. If the capture threshold has not been measured, the Automatic Pulse Amplitude parameter is set to 5.0 V.

The A. Pulse Width setting does not change when the ACap Confirm parameter is programmed to On or Monitor.

When the ACap Confirm parameter is programmed to Off or Monitor, the A. Pulse Amplitude parameter is set to 3.5 V, unless the Automatic Pulse Amplitude parameter is 3.5 V or greater, when it is set to 5.0 V.

Available In: Zephyr™ DR Devices

[23] In steps of 0.125 V.
[24] At the 1.125 and 1.375 settings, the additional increase in the pulse amplitude is 1.125 V.

Settings: On; Monitor; Off (Nominal: Off)

Accessed From: Parameters button > Brady tab > Capture & Sense button

NOTE: **High Base Rate Settings.** The ACap Confirm function does not operate at intrinsic atrial rates or Base Rate settings at or above 120 min^{-1}. If the device detects these high rates, it attempts capture measurement an hour later.

Threshold Search Delays. The device delays a scheduled atrial threshold search if one of the following conditions exist:

- Auto Mode Switch entry
- Automatic P- and R-wave measurement (see Amplitude Monitoring (page 44))
- Lead Monitoring measurement (see Lead Monitoring Parameter (page 46))
- Stored EGM processing (see Stored EGM Configuration (page 55))
- V. AutoCapture threshold search.

Elective Replacement Indicator (ERI). The device programs the ACap Confirm parameter Off when it reaches ERI. The device sets the A. Pulse Amplitude to twice the average of the last four threshold measurements up to 5.0 V, with a minimum of 2.0 V.

V. AutoCapture

The V. AutoCapture™ parameter automatically sets the device's V. Pulse Amplitude 0.25 V above the measured capture threshold and verifies capture after each pulse. If capture is lost twice in succession, the device emits a backup safety pulse of 5.0 V for each capture loss and begins to search for a new capture threshold. If no capture loss is detected, the device searches for a lower capture threshold every eight hours. A Threshold Search can be programmed every eight or 24 hours by setting the Search Frequency parameter. If a lower threshold is found during the threshold search, the device lowers the Automatic Pulse Amplitude to 0.25 V above the new capture threshold.

To operate the AutoCapture Pacing System, you must:

- Implant a low polarization, bipolar pacing lead in the ventricle (Zephyr™ devices can operate the V. AutoCapture parameter with a unipolar or bipolar pacing lead).
- Set the V. Lead Type to Uni/Bi or Single-Pass VDD[25] (Zephyr devices can operate the V. AutoCapture parameter at any Lead Type setting except Uncoded).
- Run the V. AutoCapture Setup.
- Remove the telemetry wand or the magnet from the device

When V. AutoCapture is programmed On, a number of programming changes occur:

- The programmer shows the **Automatic Pulse Amplitude** and additional AutoCapture parameters; V. Pulse Amplitude becomes unavailable.
- Automatic Pulse Amplitude is set to the last measured capture threshold plus 0.25 V up to 5.0 V. If the capture threshold has not been measured, Automatic Pulse Amplitude is set to 5.0 V.

The V. Pulse Width setting does not change when the V. AutoCapture is programmed On.

When V. AutoCapture is programmed Off, V. Pulse Amplitude is set to 3.5 V, unless the Automatic Pulse Amplitude is 3.5 V or greater, when it is set to 5.0 V.

Settings: On; Off (Nominal: Off)

Accessed From: Parameters button > Brady tab > Capture & Sense button

NOTE: **Telemetry Link.** When the telemetry wand is placed over the device, the AutoCapture Pacing System is suspended, and the Automatic Pulse Amplitude is set to 1.25 V above the last measured threshold. When the wand is removed, the AutoCapture Pacing System is resumed, a threshold search is initiated, and Automatic Pulse Amplitude is set to 0.25 V above the measured threshold.

Interactions with Other Functions. The AutoCapture Pacing System may be suspended under certain conditions. When the condition ends, the device searches for the capture threshold and resumes normal operation.

- **Noise Response.** Extension of the refractory period due to noise suspends AutoCapture Pacing System operation. The device enters High-Output Mode (5.0 V) until the noise ends. A threshold search is started after the noise ends.
- **Magnet Response.** A magnet over the device starts the High-Output Mode (if Magnet Response is set to Battery Test). If you remove the magnet, the device searches for a capture threshold and restores programmed parameters.
- **Paced AV Delay and Sensed AV Delay.** To override intrinsic conduction during capture verification and threshold search, Paced AV Delay is autoprogrammed to 50 ms and Sensed AV Delay to 25 ms in all devices except the Zephyr device.[26] Programmed settings are restored after the search is complete.
- **AutoIntrinsic Conduction Search (AICS) and V. Intrinsic Preference (VIP™).** If the AICS or VIP parameter is enabled and V. AutoCapture is On, the setting for AICS or VIP is changed to a minimum of 100 ms.[27]
- **Negative AV Hysteresis with Search.** Two consecutive capture losses turn the Negative AV Hysteresis parameter Off and return the Paced AV Delay and Sensed AV Delay parameters to their programmed settings. When capture is restored, the Negative AV Hysteresis setting is restored.
- When Negative AV Hysteresis is enabled, capture loss does not cause a 100 ms extension of the Paced AV Delay and Sensed AV Delay.

[25] In VDR models only.
[26] The AutoCapture Paced/Sensed AV Delay parameter is programmable in Zephyr devices.
[27] If AICS or VIP is set above 100 ms, the setting does not change. If Negative AV Hysteresis is enabled, AICS remains Off when V. AutoCapture is programmed On.

- **PMT Options.** The device does not search for a new threshold until the PMT Detection algorithm is complete.
- **V. Safety Standby.** If the device detects crosstalk while V. Safety Standby is enabled, the device enters High-Output Mode for that pacing cycle.
- **High Sinus Rates** during a threshold search cause the device to switch to High-Output Mode until the rate decreases, when a new threshold search begins.
- **Hysteresis Rate and VVI Mode.** If V. AutoCapture is turned on when the VVI Mode is set and the Hysteresis Rate is Off, the Hysteresis Rate is set to 10 **min**$^{-1}$ below the Base Rate to avoid fusion beats.

Long Paced/Sensed AV Delay. Use caution if you program a Long Paced AV Delay or Sensed AV Delay because these parameters are extended by 100 ms after loss of capture to reduce fusion-induced threshold searches.

Elective Replacement Indicator (ERI). V. AutoCapture is turned off when the device reaches ERI. The V. Pulse Amplitude is set to twice the average of the last four threshold measurements up to 5.0 V, and a minimum setting of 2.0 V.

Pulse Amplitude

The Pulse Amplitude parameter determines how much electrical potential is applied to the myocardium during the pacing stimulus.

For a chronic, stable lead system, a minimum 2:1 margin between the Pulse Amplitude setting and the measured capture threshold is advised for pacemaker-dependent patients. Assess capture thresholds periodically to maintain an appropriate safety margin.

Settings: (V) 0.0 – 4.0 in steps of 0.25; 4.5 – 7.5 in steps of 0.5 (Nominal: 2.5)

Accessed From: Parameters button > Brady tab > Capture & Sense button

NOTE: **V. AutoCapture™.** Pulse Amplitude is automatically set when V. AutoCapture is On.

ACap™ Confirm. The Pulse Amplitude parameter is automatically set when the ACap Confirm Parameter is set On.

Elective Replacement Indicator (ERI). As the battery voltage decreases, actual pulse amplitude (shown on the Battery & Leads tests window) decreases from the programmed setting. As the device nears ERI, carefully observe measured data values to ensure proper pacing.

Pulse Width

The Pulse Width parameter (pulse duration) determines how long the pulse amplitude is applied to the myocardium.

Settings: (ms) 0.05; 0.1 – 1.5 in steps of 0.1 (Nominal: 0.4)

Accessed From: Parameters button > Brady tab > Capture & Sense button

Amplitude Monitoring

The Amplitude Monitoring parameter turns on or off automatic daily measurement of atrial or ventricular intrinsic signals.

- The On setting turns on daily (every 23 hours) out-of clinic measurement of intrinsic signals. Each daily measurement is compiled into a weekly median and reported in the Amplitude Trend data and Follow-up EGMs on the Follow-up EGM Sense Test window[28].
- The Off setting turns off signal monitoring and addition of data into the Amplitude Trend and Follow-up EGMs.

NOTE: **Mode Availability.** Amplitude Monitoring is only available in DDD(R), DDI(R), VDD(R), and AAI(R) Modes.

Monitoring Requirements. Monitoring is only performed if there are sufficient intrinsic events and the rate is ≤ 120 **min**$^{-1}$. If the test cannot be run, continuous attempts will be made every hour until a successful measurement has been taken.

Settings: On; Off (Nominal: On)

Accessed From: Parameters button > Brady tab > Capture & Sense button

Sensitivity

The Sensitivity parameter determines the amplitude of signals to which the device's sense amplifiers respond. The higher the mV setting, the lower the sensitivity. The device detects any signal equal to or greater than the programmed Sensitivity mV setting.

To avoid potential complications associated with undersensing, maintain a margin of two to four times the intrinsic cardiac amplitude (for example, for an intrinsic signal of 4 mV, program the sensitivity to 1 or 2 mV).

Low-amplitude P- and R-waves may require a high Sensitivity setting (low mV setting) to ensure that all valid signals are sensed. If the device responds to extraneous signals or interference, a lower Sensitivity setting (higher mV setting) may help filter out those unwanted signals.

Settings:

(Atrial) (mV) 0.1; 0.2; 0.3; 0.4; 0.5; 0.75; 1.0; 1.25; 1.5; 1.75; 2.0; 2.5; 3.0; 3.5; 4.0; 5.0 (Nominal: 0.5)[29]
(Ventricular) (mV) 0.5 – 5.0 in steps of 0.5; 6 – 10 in steps of 1.0; 12.5 (Nominal: 2.0)

Accessed From: Parameters button > Brady tab > Capture & Sense button

Backup Pulse Configuration

The Backup Pulse Configuration parameter allows you to program the polarity configuration of the backup safety pulse for the ACap™ Confirm Parameter and V. AutoCapture™ parameters to either the bipolar or unipolar settings.

Settings: Unipolar; Bipolar (Nominal: Bipolar)

[28] P-waves are measured up to 5.0 mV, R-waves are measured up to 12 mV. In single-chamber devices, R-waves are measured up to 12 mV.
[29] All single-chamber devices use the V. Sensitivity settings.

Accessed From: Parameters button > Brady tab > Capture & Sense button

Search Frequency

The Search Frequency parameter selects the timing of automatic threshold searches when V. AutoCapture™ is On or when ACap™ Confirm Parameter is set to Monitor or On.

Settings: (hrs) 8; 24 (Nominal: 8)

Accessed From: Parameters button > Brady tab > Capture & Sense button

Automatic Capture Settings Window

From the Automatic Capture Settings window, you can change the settings of the following parameters:

- ACap™ Confirm Parameter (Zephyr DR devices only) (page 42)
- V. AutoCapture™ (page 43)
- Backup Pulse Configuration (page 44)
- Search Frequency (page 45)
- AutoCapture Paced/Sensed AV Delay (page 45)

Accessed From: Parameters button > Brady tab > Capture & Sense button> Automatic Capture Settings button

AutoCapture Paced/Sensed AV Delay

The AutoCapture™ Paced/Sensed AV Delay parameter sets the Paced AV Delay and Sensed AV Delay parameters used when the device performs a V. AutoCapture Threshold Search or Capture Recovery.

> NOTE: The recommended setting for this parameter is 50/25. Fusion is more likely with longer delays and may cause inaccurate threshold search results.

Available In: Zephyr™ DR Devices

Settings: 50/25; 100/70; 120/100 (Nominal: 50/25)

Accessed From: Parameters button > Brady tab > Capture & Sense button> AutoCapture Settings button

Leads

From the Leads window, you can change the settings for the following parameters:

- Lead Type (page 45)
- Pulse Configuration (page 45)
- Sense Configuration (page 46)
- Lead Monitoring Parameter (page 46)
- Lead Monitoring Window (page 47)
- Upper Limit (page 47)

Accessed From: Parameters button > Brady tab > Leads button

Lead Type

The Lead Type parameter sets the lead polarity type and restricts available settings for sense and pulse configurations to prevent inappropriate programming.

The device is shipped in the “Uncoded” setting, which allows all possible pulse and sense configurations but does not allow certain parameters (for example, V. AutoCapture™) to be programmed. The programmer prompts you to change this setting to a specific Lead Type.

The settings available for the Lead Type parameter are explained in the table below.

Table 11. Lead Type settings

Lead Type Setting	Definition
Bipolar	Restricts pulse and sense configurations to Bipolar.
Unipolar	Restricts pulse configuration to Unipolar and sense configuration to Unipolar Tip or Unipolar Ring.
Uni/Bi	Allows all pulse and sense configurations (Unipolar or Bipolar pacing; and Bipolar, Unipolar Tip, or Unipolar Ring sensing).
Uncoded	Allows all pulse and sense configurations. Prompts selection of a specific Lead Type.

Settings: Single-Pass VDD[30]; Bipolar Only; Unipolar; Uni/Bi; Uncoded (Nominal: Uncoded)

Accessed From: Parameters button > Brady tab > Leads button

Pulse Configuration

The Pulse Configuration parameter sets the anode and cathode for the device’s pacing pulse.

[30] Only available for V. Lead Type in VDR devices.

The device's Lead Type setting limits the settings available for the Pulse Configuration parameter.

Table 12. Pulse Configuration

Setting	Anode	Cathode
Unipolar	Case	Lead tip
Bipolar	Ring	Lead tip

Settings: Unipolar (tip–case); Bipolar (tip–ring) (Nominal: See Package Label)

Accessed From: Parameters button > Brady tab > Leads button

Sense Configuration

The Sense Configuration parameter sets the anode and cathode for the sensing circuit.

The device's Lead Type setting limits the settings available for the Sense Configuration parameter.

Table 13. Sense Configuration

Setting	Anode	Cathode
Unipolar Tip	Case	Lead tip
Unipolar Ring	Case	Ring
Bipolar	Ring	Lead Tip

Settings: Unipolar Tip; Bipolar; Unipolar Ring (Nominal: See Package Label)

Accessed From: Parameters button > Brady tab > Leads button

Lead Monitoring Parameter

The Lead Monitoring parameter enables automatic monitoring of lead impedance values and automatic switching of the Pulse Configuration and Sense Configuration settings if a lead measurement is out of range (range settings are programmable). The settings include:

- **Off.** Turns off the lead monitoring feature.
- **Monitor.** The device measures lead impedance once a day and collects the data in the Lead Impedance Trend (see Lead Impedance (page 28)). To set the lead impedance's Upper Limit, select the button below the Lead Monitoring button on the Leads window, which opens the Lead Monitoring window.
- **Polarity Switch.** The device:
  - Measures lead impedance once a day
  - Collects data in the Lead Impedance Trend (see Lead Impedance (page 28)).

  At the Polarity Switch setting, the device changes the following parameter settings if it measures impedance values outside the Lower or Upper Limit:
  - Pulse and Sense Configuration from Bipolar to Unipolar.
  - Pulse Amplitude to a minimum of 5 V
  - V. Sensitivity to a maximum of 2.0 mV
  - A. Sensitivity to a maximum of 1.0 mV.

  The Polarity Switch setting is not available if:
  - The A. or V. Lead Type parameter is set to Uncoded, Unipolar, or Bipolar Only
  - A. or V. Pulse Configuration is set to Unipolar

  If the user programs one of these conditions, the Lead Impedance parameter is autoprogrammed to the Monitor setting.

Settings: Off; Monitor; Polarity Switch (Nominal: Off)

Accessed From: Parameters button > Brady tab > Leads button

NOTE: **Implant Date.** When the user sets an Implant Date (see Patient Data (page 7)), the programmer autoprograms the Lead Monitoring parameter from the Off to the Monitor setting.

Lower Limit. This setting is 200 Ω and is not programmable.

Pulse Amplitude is set to a minimum of 2.5 V during lead monitoring. An additional 1.0 V is added if the AutoCapture™ Pacing System is On when lead impedance measurement occurs.

Unipolar Setting. The lead impedance measurement is only taken in the pacing configuration. Therefore, if a bipolar lead is programmed to the unipolar pulse configuration, an outer conductor or insulation failure would not be detected by lead monitoring.

Monitoring During Sensed Events. Lead impedance measurements are taken during paced events. During intrinsic activity, triggered pacing occurs 20 ms after each sensed event to allow for lead impedance measurement.

Unipolar Failure. If the lead monitoring algorithm switches the pacing configuration to Unipolar and there is also a failure in the Unipolar configuration, the pacing function will not be restored.

Suspension of Measurement. Lead impedance measurement is inhibited when:

- The average intrinsic rate in the respective chamber is greater than 170 min^{-1}
- Five or more PVCs are detected[31]
- A magnet is applied[32]

Lead Monitoring Window

From the Lead Monitoring window, you can change the settings for the following parameters:

- Lead Monitoring Parameter (page 46)
- Upper Limit (page 47)

Upper Limit

The Upper Limit parameter sets the maximum normal lead impedance value that can be measured by the device when the Lead Monitoring Parameter is enabled. Any measured impedance value above this setting sets a high impedance alert. If the setting for the Lead Monitoring parameter is Polarity Switch, the device also changes the Pulse Configuration parameter from Bipolar to Unipolar.

NOTE: **Lower Limit.** This setting is 200 Ω and is not programmable.

Settings: (Ω) 750; 1000; 1250; 1500; 1750; 2000 (Nominal: 2000)

Accessed From: Parameters button > Brady tab > Leads button > Lower Limit/Upper Limit button

Refractories & Blanking

From the Refractories & Blanking window, you can change the settings for the following parameters:

- A. Refractory Period (PVARP) (page 47)
- A. Absolute Refractory Period (page 48)
- V. Refractory Period (page 48)
- Rate Responsive PVARP/VREF (page 48)
- Shortest PVARP/VREF (page 49)
- Post Ventricular Atrial Blanking (PVAB) (page 49)
- V. Blanking (page 49)
- V. Safety Standby (page 50)
- PVC Options (page 50)
- PMT Options (page 51)
- PMT Detection Rate (page 51)

Accessed From: Parameters button > Brady tab > Refractories & Blanking button

A. Refractory Period (PVARP)

The A. Refractory Period parameter sets the portion of the pacing cycle unresponsive to signals from the atrial sensing circuit to avoid inappropriate response to stimuli. In dual-chamber modes, the A. Refractory parameter is designated as the PVARP parameter (post ventricular atrial refractory period).

In AAI(R) and AAT(R) modes, the A. Refractory Period begins after a P-wave or an atrial stimulus. In VDD(R), DDD(R), and DDI(R) modes, the PVARP begins after an R-wave or a ventricular stimulus[33].

The A. Refractory Period is made up of two segments: (1) an absolute refractory period of 60 ms, when all signals to the device are blocked; and (2) a relative refractory period or noise sampling period, which is the programmed setting minus 60 ms. If the device detects noise during the relative refractory period, it extends the refractory period to avoid inappropriate pacing. See Noise Response (page 48).

The A. Refractory Period setting can automatically adjust to changes in the pacing rate. See Rate Responsive PVARP/VREF (page 48).

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: (ms) 125 – 500 in steps of 25 (Nominal: 275)[34]

Accessed From: Parameters button > Brady tab > Refractories & Blanking button

[31] When measuring atrial lead impedance only.
[32] Lead impedance measurement will complete once the magnet is removed.
[33] The atrial channel is also refractory during the Sensed/Paced AV Delay. Thus in DDD(R) and DDI(R), the Total Atrial Refractory Period (TARP) = Sensed/Paced AV Delay + PVARP. In VDD(R), the Total Atrial Refractory Period (TARP) = Sensed AV Delay + PVARP.
[34] For AAI and AAT modes, the nominal A. Refractory Period is 400 ms.

Noise Response

Electromagnetic interference or "noise" of at least 400 Hz (not caused by myopotentials) sensed during the relative refractory period triggers a noise response. Noise detected in the ventricular channel during DDD or DDI mode operation extends both the ventricular and atrial refractory periods.

The noise response is an extension of the refractory period for an additional 150 ms (noise sampling period). The first 75 ms are an absolute refractory period and the final 75 ms are a relative refractory period. The relative period for the atrial channel is 25 ms. If no noise is detected in the relative period, the device resumes normal operation. Continued noise adds another 150 ms noise sampling period.

In the presence of continuously sensed noise, the device reverts to asynchronous operation at the programmed Base Rate setting or the Sensor-indicated rate and continues until the noise ceases. Then the device resumes normal operation.

> **CAUTION: Sensed atrial events that occur faster than the noise sampling period initiate the device's noise response on the atrial channel (DVI pacing). Thus, high atrial rates result in asynchronous pacing when rates faster than 600 $\mathbf{min^{-1}}$ are sensed.**

A. Absolute Refractory Period

The A. Absolute Refractory Period starts after an atrial paced or sensed event in the atrial alert period. No events are detected during the absolute refractory period. This is followed by the relative refractory period, which is equal to the programmed A. Refractory Period setting minus the A. Absolute Refractory Period setting.

See A. Refractory Period (PVARP (page 47)).

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: (ms) 60; 80; 100 – 350 in steps of 25 (Nominal: 60)

Accessed From: Parameters button > Brady tab > Refractories & Blanking button

V. Refractory Period

The V. Refractory Period parameter sets the portion of the pacing cycle unresponsive to signals from the ventricular sensing circuit to avoid inappropriate responses to stimuli.

In DDI(R), VDD(R), DDD(R), VVI(R), and VVT(R) modes, the V. Refractory Period begins after an R-wave, PVC, or ventricular stimulus.

The V. Refractory Period is made up of two segments: (1) an absolute refractory period of 60 ms, when all signals to the device are blocked; and (2) a relative refractory period or noise sampling period, which is the programmed setting minus 60 ms. If the device detects noise during the relative refractory period, it extends the refractory period to avoid inappropriate pacing. See Noise Response (page 48).

The V. Refractory Period setting can automatically adjust to changes in the pacing rate. See Rate Responsive PVARP/VREF (page 48).

Settings: (ms) 125 – 500 in steps of 25 (Nominal: 250)

Accessed From: Parameters button > Brady tab > Refractories & Blanking button

Rate Responsive PVARP/VREF

The Rate Responsive PVARP/VREF parameter automatically changes the Refractory Period settings in response to increases or decreases in the filtered atrial rate interval (FARI)[35]. A Low setting changes the Refractory Period settings by one ms for each one $\mathbf{min^{-1}}$ change in the pacing rate. A High setting changes the Refractory Period settings by three ms for each one $\mathbf{min^{-1}}$ change in the pacing rate. Thus as pacing rates rise, the device decreases both Refractory Period settings until the Max Sensor Rate, Max Track Rate, or Shortest PVARP/VREF setting is reached.

The algorithm begins to operate when the intrinsic rate or pacing rate exceeds 90 $\mathbf{min^{-1}}$. When the rate falls below 90 $\mathbf{min^{-1}}$, the algorithm is suspended. The pacing rate is determined by whichever rate is highest: Base Rate, Sensor-indicated rate, AMS Base Rate, Intervention Rate, or AF Suppression™ Parameter-driven rate.

The Rate Responsive PVARP/VREF parameter is available in DDD(R), VDD(R), DDI(R), DVI(R), VVI(R), and AAI(R) modes. When the mode is set to VVI, this parameter is identified as "Rate Responsive Ventricular Refractory." In AAI mode, this parameter is identified as "Rate Responsive Atrial Refractory."

Available In: Sustain™ XL DC, DR, SR; Victory™; Zephyr™ Devices

Settings: Off; Low; Medium; High (Nominal: Low)

Accessed From: Parameters button > Brady tab > Refractories & Blanking button

NOTE: **Sensor.** The Rate Responsive PVARP/VREF parameter is available at any Sensor setting.

PVARP and VREF Spread. As it alters the refractory periods, the algorithm attempts to maintain a 25 ms spread between PVARP and VREF. If PVARP is set at > 25 ms above VREF, PVARP shortens until it is 25 ms greater than the VREF setting. Thereafter, both PVARP and VREF decrease concurrently, but maintain their 25 ms spread. If the difference between settings for PVARP and VREF is less than 25 ms, then both settings change concurrently.

Intrinsic Rate Changes and Mode. In DDI(R), the algorithm only responds to changes in the pacing rate, not the intrinsic rate. In DVI(R), VVI(R), and AAI(R) modes, Rate Responsive PVARP/VREF alters only the VREF or AREF (Atrial Refractory Period) and is not affected by changes in the intrinsic rate. The refractory period begins to shorten when the pacing rate exceeds 90 $\mathbf{min^{-1}}$.

[35] In single-chamber modes and DVI mode, this parameter is named Rate Responsive V. Refractory or Rate Responsive A. Refractory based on the Lead Type setting.

Mode Switch Behavior. When the device has mode-switched to DDI(R) or VVI(R) mode, the PVARP parameter is autoprogrammed to the current Post Ventricular Atrial Blanking (PVAB) setting, which overrides the Rate Responsive PVARP. (VREF is not affected.)

AF Suppression™ Algorithm Behavior. If the Rate Responsive PVARP/VREF parameter is set to Off or Low, it is autoprogrammed to High when AF Suppression Parameter is programmed On.

Shortest PVARP/VREF

The Shortest PVARP/VREF parameter sets the lowest allowable length for the A. Refractory, PVARP and/or the V. Refractory Period parameters when the Rate Responsive PVARP/VREF parameter is enabled.

When the mode is set to VVI, this parameter is identified as "Shortest Ventricular Refractory." In AAI mode, this parameter is identified as "Shortest Atrial Refractory."

Available In: Sustain™ XL DC, DR, SR; Victory™; Zephyr™ Devices

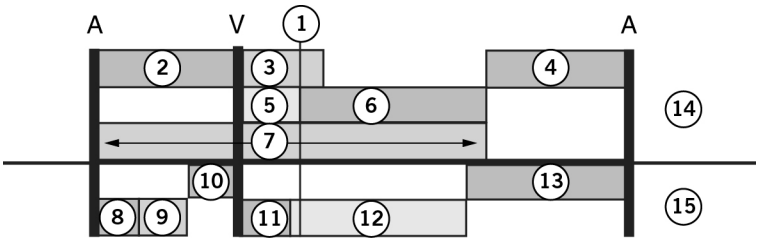
Settings: (ms) 120 – 350 in steps of 10 (Nominal: 170)

Accessed From: Parameters button > Brady tab > Refractories & Blanking button

Post Ventricular Atrial Blanking (PVAB)

The PVAB parameter sets the period during which atrial channel far-field events following a ventricular pulse are eliminated from the atrial rate calculation (that is, the Filtered Atrial Rate Interval)[36]. These far-field events cannot be used to increase the pacing rate.

Figure 9. Post Ventricular Atrial Blanking (PVAB) (AV Stimulation)



1. Far-Field Event
2. Paced AV Delay
3. PVAB
4. Alert for P-Waves
5. Absolute Portion of PVARP
6. PVARP
7. Total Atrial Refractory Period
8. Vent Blanking
9. Crosstalk Detection Window (VSS
10. Alert for R-Waves
11. Absolute Portion of Ventricular Refractory
12. Ventricular Refractory
13. Alert for R-Waves
14. Atrial Channel
15. Ventricular Channel

If the PVAB setting is too long, the device may lose the ability to sense events in periods of very high atrial rates, which could result in a delayed mode-switch. A short PVAB setting may allow sensing of a far-field ventricular evoked response, which could result in a delay in exiting a mode-switch or a mode-switch at a lower atrial rate.

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: (ms) 60; 70; 80; 85; 95; 100; 110; 115; 125; 130; 140; 150; 155; 165; 170; 180; 185; 195; 200 (Nominal: 150)

Accessed From: Parameters button > Brady tab > Refractories & Blanking button

NOTE: **Refractory Periods and PVCs.** While atrial sensed events inside the PVAB period are not used to calculate the FARI, they can be used to extend the A. Refractory Period (PVARP) (as part of the device's Noise Response) and to detect PVCs for the PVC Options algorithm.

V. Blanking

The V. Blanking parameter sets a period during which all ventricular events following an atrial pulse are eliminated from the ventricular pacing rate calculation. This blanking of the ventricular channel minimizes the possibility that an atrial pulse may inhibit the ventricular output. Sensed P-waves are not affected by the V. Blanking parameter.

Zephyr™ DR devices also provide an "Auto" setting, in which the device sets the first 12 ms of the V. Blanking period as an absolute refractory period, followed by an alert period of 12 ms in which the device is alert to signals in the ventricular channel. If the device does not sense a signal, it ends the V. Blanking period at the end of the additional 12 ms. If the device senses a ventricular signal during that period, it increases the blanking period by an additional 12 ms. Continued sensing of ventricular signals adds additional

[36] The device uses the Filtered Atrial Rate Interval (FARI) rather than the actual measured atrial rate in the computation of such algorithms as Auto Mode Switch and Rate Responsive AV Delay. For more information on FARI, see Auto Mode Switch.

12 ms intervals (at the point of sensing) to the blanking period until the blanking period reaches a maximum of 52 ms or until the device senses no ventricular signals. Once the refractory interval cycle has terminated, the device reverts to normal alert status. If the V. Safety Standby parameter is On when the blanking period reaches it maximum of 52 ms, then the device begins a 12 ms crosstalk detection window. If an atrial event is detected during that window, the device emits a ventricular pulse 120 ms after the atrial event.

See Crosstalk (page 50).

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr DR Devices

Settings: (Sustain, Victory) (ms) 12 – 52 in steps of 4 (Nominal: 12) (Zephyr) (ms) Auto; 12 – 52 in steps of 4 (Nominal: Auto)

Accessed From: Parameters button > Brady tab > Refractories & Blanking button

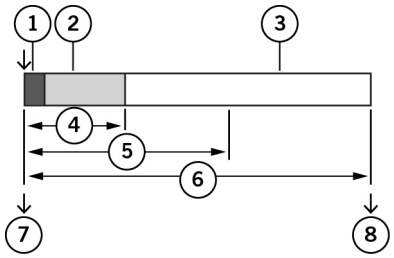
NOTE: The length of the V. Blanking period is subtracted from the crosstalk detection window instituted by the V. Safety Standby parameter. In Zephyr DR devices, the Auto setting is not available when the High V. Rate Trigger parameter is enabled. When the High V. Rate Trigger parameter is enabled, a V. Blanking setting of Auto is autoprogrammed to 12 ms and V. Safety Standby is autoprogrammed On.

V. Safety Standby

The V. Safety Standby parameter enables a "crosstalk detection window" immediately following the V. Blanking period where the detection of an atrial pulse in the ventricular channel triggers a ventricular pulse 120 ms after the event[37]. This algorithm ensures that an atrial pulse detected by the ventricular channel immediately after the atrial pulse does not inhibit ventricular pacing.

The duration of the crosstalk detection window is 64 ms minus the programmed V. Blanking period setting, which takes up the initial portion of the crosstalk detection window (see the figure below).

Figure 10. Crosstalk detection window during the Paced AV Delay



1. Ventricular Blanking Period
2. Crosstalk Detection Window
3. Normal Sensing
4. 64 ms
5. 120 ms
6. Paced AV Delay
7. Atrial Output Pulse
8. Ventricular Output Pulse

If another ventricular event is detected after the crosstalk detection window has ended, the device assumes the second pulse is an R-wave and inhibits the ventricular pulse.

See Crosstalk (page 50).

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: Off; On (Nominal: On)

Accessed From: Parameters button > Brady tab > Refractories & Blanking button

Crosstalk

Crosstalk is the inappropriate detection of an atrial output pulse by the ventricular channel that inhibits the ventricular pulse. Any dual-chamber device that provides a wide range of programmable atrial outputs and ventricular sensitivities may be susceptible to crosstalk. Clinically, crosstalk is identified by atrial pacing with no ventricular-channel output and occurs with the following programmed settings:

- High A. Pulse Amplitude
- High V. Sensitivity
- Short V. Blanking
- Rapid pacing rates
- Unipolar sense and pulse configurations

Crosstalk can be eliminated if the A. Pulse Amplitude is decreased, the V. Sensitivity is decreased, or the V. Blanking Period is increased, as long as the settings are consistent with the safe operation of the patient's device.

PVC Options

The PVC Options parameter detects and responds to premature ventricular contractions (PVCs) when the device is in DDD(R) or VDDD(R) modes. The PVC Options algorithm detects a PVC if: (1) an R-wave is not preceded by an atrial event; or (2) a P-wave is detected in the relative refractory portion of the A. Refractory Period (PVARP) but is not followed by an R-wave within 280 ms of the atrial event.

The +PVARP on PVC setting is a response option available in VDD(R) modes. In this setting when the device confirms a PVC, it adds 125 ms to the current PVARP setting, up to 550 ms.

DDD(R) modes offer the A Pace on PVC setting as a response to a PVC confirmation. The response consists of an extension of the PVARP setting to 480 ms (150 ms absolute, 330 ms relative). Atrial activity sensed during the relative portion of the refractory period

[37] If the Paced AV Delay or the Rate Responsive AV Delay is shorter than 120 ms, the V. pulse is delivered at that interval.

is considered a retrograde P-wave. If within the next 330 ms, the device does not detect further atrial activity, it emits an A pulse, followed by a V pulse after the programmed Paced AV Delay setting. If the device does sense atrial activity between 120 and 330 ms after the retrograde P-wave, the device resumes normal DDD timing.

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: Off; A Pace on PVC (Nominal: Off)[38]

Accessed From: Parameters button > Brady tab > Refractories & Blanking button

NOTE: **Episodes.** Zephyr DR, Sustain XL DC, DR, and Victory DR devices can store an episode on detection of consecutive PVCs. See PVC Trigger (page 57).

Diagnostics. The Rates window reports the total number of PVCs detected by the device.

Magnet Response. If Magnet Response is programmed to Battery Test, the PVC response is suspended while a magnet is over the device.

PMT Options

The PMT Options parameter provides two algorithms to detect and respond to pacemaker-mediated tachycardia (PMT):

- 10 Beats > PMT
- Auto Detect

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: Off; 10 Beats > PMT; Auto Detect[39] (Nominal: Off) (Nominal: Auto Detect)

Accessed From: Parameters button > Brady tab > Refractories & Blanking button

10 Beats > PMT

Detection. If the device counts ten consecutive AS-VP events at a rate greater than the PMT Detection Rate, it confirms PMT.

Response. After the tenth AS-VP event, the device resets the A. Refractory Period (PVARP) setting to 480 ms for a single cycle. This makes the device unresponsive to retrograde P-waves and effectively terminates the PMT. This is followed by an atrial alert period of 330 ms.

After the PVARP setting is extended, PMT detection is suspended for 256 cycles, after which it is repeated.

Auto Detect

Detection (Sustain XL DC, DR, Victory DR, and Zephyr DR Devices). If the device detects eight consecutive P–P intervals above the PMT Detection Rate, the device calculates the stability of the eight VP-AS intervals. If the device determines that the VP-AS intervals are stable, then for the ninth interval, the device:

- Shortens the Sensed AV Delay by 50 ms (if the AS-VP interval is ≥ 100 ms).
- Increases the Sensed AV Delay by 50 ms (if the AS-VP interval is < 100 ms).

If the tenth VP-AS interval is nearly equal to the ninth VP-AS interval, the device concludes that PMT is present and begins its response. If the ninth and tenth intervals differ by more than 16 ms, then the device concludes that PMT is not present and the detection algorithm is repeated after 256 cycles.

Response. The device suspends the ventricular output and delivers an atrial pulse 330 ms after the detected retrograde P-wave, followed by normal operation[40].

NOTE: **Auto Mode Switch and Magnet Response.** Both PMT algorithms are suspended during an Auto Mode Switch or during a magnet application (if the Magnet Response is programmed to Battery Test).

10 Beats > PMT. If a P-wave is detected in the 480 ms absolute refractory period, it is counted in the computation of FARI, but is not shown on the Markers. A second P-wave detected in the 480 ms period is neither counted nor shown[41].

PMT Detection Rate

The PMT Detection Rate parameter determines at what rate the device becomes alert to the presence of pacemaker-mediated tachycardia (PMT) when the PMT Options parameter is enabled. The settings begin at 90 **min^{-1}** (or higher if the Base Rate parameter is programmed above 90 **min^{-1}**) and do not exceed the Max Track Rate (MTR) setting.

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: (**min^{-1}**) 90 – 150 in steps of 5; 160 – 180 in steps of 10 (Nominal: 110)

Accessed From: Parameters button > Brady tab > Refractories & Blanking button

NOTE: **Interaction with Base Rate.** The PMT Detection Rate parameter cannot be programmed to a setting less than the Base Rate, and is autoprogrammed to a setting 10 **min^{-1}** above the Base Rate if you attempt to program the Base Rate equal to or above the PMT Detection Rate.

Interaction with Max Track Rate (MTR). The PMT Detection Rate parameter cannot be programmed to greater than the MTR. The PMT Detection Rate is autoprogrammed to a setting equal to the MTR if you attempt to program the MTR to a setting below the PMT Detection Rate.

[38] When the devices are set to VDD(R) modes, the only available setting is +PVARP on PVC.
[39] Auto Detect is not available in VDD(R) mode.
[40] The atrial pulse may be inhibited if a P-wave is detected during an alert period of 210 ms following the 60 ms absolute ventricular refractory period.
[41] Events that occur in the PVAB period are also not counted or shown.

AT/AF Detection & Response

From the AT/AF Detection & Response window, you can change the settings for the following parameters:

- Auto Mode Switch (page 52)
- Atrial Tachycardia Detection Rate (page 53)
- AMS Base Rate (page 53)
- AF Suppression™ Parameter (page 53)
- Overdrive Pacing Cycles (page 53)
- Maximum AF Suppression Rate (page 54)

Accessed From: Parameters button > Brady tab > AT/AF Detection & Response button

Auto Mode Switch

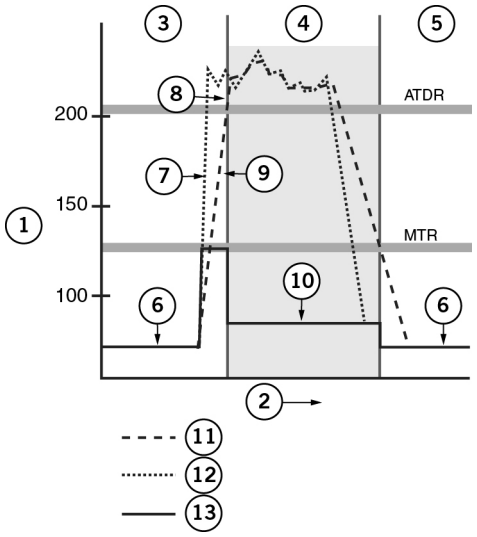
The Auto Mode Switch (AMS) parameter prevents atrial-based timing modes from tracking atrial tachycardias and causing pacemaker-mediated tachycardia (PMT). The Auto Mode Switch algorithm switches the mode from DDD(R) or VDD(R) to a ventricular-timing mode (DDI, DDIR, VVI, or VVIR) when the atrial rate surpasses the Atrial Tachycardia Detection Rate (ATDR) setting. At mode-switch, the device paces in the ventricle at the AMS Base Rate setting.

Rather than use the actual atrial rate, which cannot always distinguish between sustained tachycardia and intermittent fast cycles, AMS uses the Filtered Atrial Rate Interval (FARI), which is based on a comparison of the current atrial rate to a continually updated average rate.

When the tachyarrhythmia subsides and the FARI falls below the Max Track Rate (MTR) setting or the Sensor-indicated rate (whichever is faster), the device switches back to DDD(R) or VDD(R) operation.

The example in the figure below shows the behavior of the device in DDD mode with the AMS parameter set to DDI and the ATDR parameter set to 210 min^{-1}. Initially, the atrial rate rises rapidly from 70 min^{-1} to over 200 min^{-1}, while the FARI rises more gradually. The ventricular rate rises until it reaches the MTR setting. When the FARI exceeds the ATDR setting, the device switches to the DDI mode. The ventricular rate falls from the MTR setting to the AMS Base Rate setting. As the tachycardia subsides, the FARI decreases more slowly than the actual atrial rate. When the FARI falls below the MTR setting, the mode switches back to DDD. The ventricular rate is then defined by the atrial rate.

Figure 11. Auto Mode Switch



1. Paced Rate (min^{-1})
2. Time
3. Atrial Tracking DDD
4. Ventricular Tracking DDI
5. Atrial Tracking DDD
6. Base Rate
7. Atrial Rate
8. Auto Mode Switch Entry
9. Filtered Atrial Rate
10. AMS Base Rate
11. Filtered Atrial Rate Interval (FARI)
12. Intrinsic Atrial Rate
13. AMS Base Rate (Ventricular Rate)

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: Off; DDD to DDI; DDD to DDIR; DDDR to DDI; DDDR to DDIR; VDD to VVI; VDD to VVIR; VDDR to VVI; VDDR to VVIR (Nominal: DDIR)

Accessed From: Parameters button > Brady tab > AT/AF Detection & Response button

NOTE: **Diagnostics.** When the Auto Mode Switch parameter is enabled, it resets the diagnostic data collection from AT/AF Histograms to mode-switch data. See Mode Switch Diagnostics (page 12).

Episodes. The device can store episodes of AMS Entry and/or Exit.

PVARP During Mode Switch. During a mode-switch, the A. Refractory Period (PVARP) is replaced by the programmed setting of the Post Ventricular Atrial Blanking (PVAB). The lowest available PVAB period during a mode-switch (and thus, the lowest PVARP) is 110 ms.

Rest Rate. While the device is operating at the AMS Base Rate, the Rest Rate parameter operates at the Base Rate setting.

Atrial Tachycardia Detection Rate

The Atrial Tachycardia Detection Rate (ATDR) parameter sets the atrial rate at which the device mode-switches when the Auto Mode Switch parameter is enabled. A mode-switch occurs when the Filtered Atrial Rate Interval (FARI) exceeds the programmed ATDR setting. The device switches back to the atrial-based mode when the FARI falls below the Max Track Rate (MTR) setting or the Sensor-indicated rate. The ATDR parameter is always available because it is also used as the threshold for the AT/AF setting for the Atrial Trigger parameter and is shown on the Trigger Options screen. Atrial events at rates greater than the ATDR setting are recorded in the AT/AF Summary and AF Suppression™ Diagnostics.

See AT/AF Definition (page 14).

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: (min^{-1}) 110 – 150 in steps of 5; 160 – 200 in steps of 10; 225 – 300 in steps of 25 (Nominal: 180)

Accessed From: Parameters button > Brady tab > AT/AF Detection & Response button

AMS Base Rate

The AMS Base Rate parameter sets the ventricular pacing rate when the device has switched from an atrial-timing mode to ventricular timing. When the device returns to DDD(R) or VDD(R) modes, the device resumes pacing at the programmed Base Rate setting. The AMS Base Rate parameter is only available when the Auto Mode Switch parameter is enabled.

Unless the AMS Base Rate parameter is programmed to a specific setting, it is autoprogrammed to equal the permanently programmed Base Rate setting.

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: (min^{-1}) Base Rate +0 to Base Rate +35 in steps of 5[42] (Nominal: 80)

Accessed From: Parameters button > Brady tab > AT/AF Detection & Response button

AF Suppression™ Parameter

The AF Suppression™ parameter enables the device to pace the atrium at rates faster than the intrinsic atrial rate in order to suppress paroxysmal or persistent atrial fibrillation (AF). The AF Suppression algorithm is available in AAI(R) and DDD(R) modes.

When the algorithm detects two P-waves in a 16-cycle window, the device increases the pacing rate to overdrive the intrinsic conduction. After pacing at the AF Suppression rate for the number of cycles set by the Overdrive Pacing Cycles parameter, the device steps down its rate until it senses an additional two P-waves, resuming overdrive pacing. If two P-waves are not sensed, it resumes operation at the Base Rate setting, the Rest Rate setting, or the Sensor-indicated rate.

Diagnostic data on AF Suppression can be found in the AF Suppression Diagnostics (page 13).

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: On; Off (Nominal: Off)

Accessed From: Parameters button > Brady tab > AT/AF Detection & Response button

NOTE: **Auto Mode Switch.** If a mode-switch occurs, the AF Suppression algorithm is disabled, and the rate is set to the Base Rate, AMS Base Rate, or Sensor-indicated rate.

Tests. AF Suppression is temporarily turned off during Sense Tests and NIPS.

Hysteresis Rate is autoprogrammed Off when AF Suppression is programmed On.

Max Sensor Rate and Maximum AF Suppression Rate. AF Suppression does not increase atrial rates above the settings for these parameters.

Rate-Modulated Stimulation. The paced rate increases to the Sensor-indicated rate when it is greater than the current AF Suppression rate.

Rate Responsive AV Delay. If this parameter is set to Off or Low, it is autoprogrammed to Medium when AF Suppression is programmed On.

Rate Responsive PVARP/VREF. If this parameter is set to Off or Low, it is autoprogrammed to High when AF Suppression is programmed On.

Elective Replacement Indicator (ERI). At ERI, AF Suppression is programmed Off.

Magnet Response. AF Suppression is suspended when a magnet is applied. Upon suspension, the device operates at either the Base Rate or the Sensor-indicated rate (whichever is higher). Upon removal of the magnet, AF Suppression is restarted when two P-waves are sensed.

Overdrive Pacing Cycles

The Overdrive Pacing Cycles parameter is the number of cycles the device overdrives the pacing rate before the AF Suppression™ algorithm begins to decrease the rate to the Base Rate setting, the Rest Rate setting, or the Sensor-indicated rate.

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: (cycles) 15; 20; 25; 30; 35; 40 (Nominal: 15)

Accessed From: Parameters button > Brady tab > AT/AF Detection & Response button

[42] These represent formulas to compute AMS Base Rate settings. Actual settings appear as numerical rates.

Maximum AF Suppression™ Rate

The Maximum AF Suppression™ Rate parameter is the upper limit that the AF Suppression-driven rate can reach. The Maximum AF Suppression Rate parameter cannot be programmed to a rate above the Max Sensor Rate, and the programmer does not display settings above the Max Sensor Rate.

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: (min^{-1}) 80 – 150 in steps of 5; 160 – 180 in steps of 10 (Nominal: 120)

Accessed From: Parameters button > Brady tab > AT/AF Detection & Response button

Episode Settings

The Episode Settings window contains two buttons that can be used to program the episode triggers and the way stored episodes are configured:

- **Stored EGM Configuration** (page 55). These parameters determine the number, length, and format of episodes.
- **Episode Triggers** (page 56). These parameters determine which events trigger an episode.

For information on episode diagnostics, see Episodes (page 9).

Accessed From: Parameters button > Episodes Settings tab

Stored EGM Configuration

From the Stored EGM window, you can change the settings for the following parameters:

- Sampling Option (page 55)
- Number of Stored Episodes (page 55)
- Channel (page 55)
- EGM Configuration (page 55)
- Recording Range (page 56)

Accessed From: Parameters button > Episodes Settings tab > Stored EGM Configuration button

Sampling Option

The Sampling Option parameter determines how the device treats episodes after the memory is full. There are two options:

- **Freeze** instructs the device to stop additional data collection.
- **Continuous** allows a new stored EGM to overwrite the oldest stored EGM.

Settings: Freeze; Continuous (Nominal: Freeze)

Accessed From: Parameters button > Episodes Settings tab > Stored EGM Configuration button

NOTE: **Clear Episodes.** All episode data are cleared when the Sampling Option setting is changed.

Number of Stored Episodes

The Number of Stored Episodes parameter sets the total number of episodes stored in the device. Indirectly, this parameter also sets the length of each episode. A low setting allows for longer episodes. A high setting results in shorter episodes.

The duration of each episode is also determined by the setting of the Channel parameter. Typical durations for each setting are found in the table below (page 55).

The programmer shows the maximum duration of the episodes beneath the Number of Stored Episodes button.

Settings: 1; 2; 4; 8; 12 (Nominal: 4)

Accessed From: Parameters button > Episodes Settings tab > Stored EGM Configuration button

NOTE: **Clear Episodes.** All episode data are cleared when the Number of Stored Episodes setting is changed.

Channel

The Channel parameter determines the number of EGM channels recorded in the episode (single or dual). The type of EGM recorded is determined by the EGM Configuration parameter. The available options depend upon the programmed Mode.

The Channel parameter setting also affects the length of the episodes. The table below shows the duration of a typical episode (based on a nominal rate of 60 min^{-1}) for each setting of Number of Stored Episodes and Channel. Actual maximum durations based on the device's programmed settings are shown beneath the Number of Stored Episodes button.

Table 14. Duration of a typical episode for each setting of Number of Stored EGMs and Channel

Number of Stored EGMs	Approximate Duration (in seconds)	
	Dual-Channel	Single-Channel
1	35	120
2	22	70
4	12	40
8	6	20
12	4	12

Settings: Dual; Single (Nominal: Dual for dual-chamber modes; Single for single-chamber modes)

Accessed From: Parameters button > Episodes Settings tab > Stored EGM Configuration button

EGM Configuration

The EGM Configuration parameter sets the channel's EGM source. Two EGM Configuration parameters (atrial and ventricular) are available when the Channel parameter is set to Dual. When the Channel parameter is set to Single, only one EGM Configuration parameter is available.

When V. AutoCapture is programmed On, the V. EGM Configuration parameter is autoprogrammed to the V Bipolar setting and is not programmable[43].

Available EGM Configuration settings are contingent upon the settings for the Lead Type and Channel parameters.

Settings:

(**Atrial**) A Bipolar; A Unipolar Tip; A Unipolar Ring; Atip-Vtip; Aring-Vtip; (Nominal: A Bipolar)

(**Ventricular**) V Bipolar; V Unipolar Tip; V Unipolar Ring; Atip-Vtip; Aring-Vtip; Aring-Vring (Nominal: V Bipolar)

Accessed From: Parameters button > Episodes Settings tab > Stored EGM Configuration button

Recording Range

The Recording Range parameter sets the EGM gain for the stored episode. Two EGM Recording Range parameters (atrial and ventricular) are available when the Channel parameter is set to Dual. When the Channel parameter is set to Single, one EGM Recording Range parameter is available.

Settings:

(**Atrial**) (mV) ±15.0; ±7.5; ±3.0; ±1.5 (Nominal: ±3.0)

(**Ventricular**) (mV) ±15.0; ±7.5; ±3.0; ±1.5 (Nominal: ±15.0)

Accessed From: Parameters button > Episodes Settings tab > Stored EGM Configuration button

Episode Triggers

From the Episode Triggers window, you can change the settings for the following parameters:

- Atrial Trigger (page 56)
- Trigger Type (page 56)
- High A. Rate Trigger (page 57)
- Consecutive Cycles (page 57)
- High V. Rate Trigger (page 57)
- PVC Trigger (page 57)
- Consecutive PVCs (page 57)
- Advanced Hysteresis Trigger (page 57)
- PMT Detection Trigger (page 57)
- Magnet Placement Trigger (page 57)

Accessed From: Parameters button > Episodes Settings tab > Episode Triggers button

Atrial Trigger

The Atrial Trigger parameter has three settings to capture atrial event episodes:

- **AMS.** This setting records an episode when the device switches into and/or out of mode-switch. The Auto Mode Switch parameter must be enabled for this trigger to be available. When the AMS trigger is selected, the Trigger Type parameter appears, which allows you to choose to trigger an episode on AMS Entry, AMS Exit, or both.
- **AT/AF.** This setting records an episode when the intrinsic rate exceeds the Atrial Tachycardia Detection Rate (ATDR) setting. When the AT/AF setting is selected, the window displays the ATDR setting. When this trigger is set, the device records data in the AT/AF Histograms. See AT/AF Definition (page 14).
- **High Atrial Rate.** This setting records an episode when the atrial rate exceeds the rate set by the High A. Rate Trigger parameter and when the high atrial rate lasts longer than the number of Consecutive Cycles parameter. These related parameters appear when the High Atrial Rate setting is selected. This setting has no effect on diagnostic data collection or mode-switching.

Settings:

(Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR) Off; AMS; AT/AF; High Atrial Rate (Nominal: Off)

(Sustain XL SR, SC; Victory SR; Zephyr SR) Off; AT/AF; High Atrial Rate (Nominal: Off)

Accessed From: Parameters button > Episodes Settings tab > Episode Triggers button

NOTE: **Auto Mode Switch.** When you program the Auto Mode Switch parameter Off, the A. Episode Trigger parameter (if enabled) is autoprogrammed Off. The device switches diagnostic data collection from Mode Switch Diagnostics to AT/AF Histograms.

Diagnostic Data Clearing. Reprogramming the A. Episode Trigger parameter clears the diagnostic data.

Trigger Type

The Trigger Type parameter selects the type of Auto Mode Switch (AMS) event that triggers an episode. This parameter becomes available when the AMS setting for the Atrial Trigger parameter is chosen.

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: Entry & Exit; Exit; Entry (Nominal: Entry)

Accessed From: Parameters button > Episodes Settings tab > Episode Triggers button > AMS Atrial Trigger

[43] In Zephyr devices the V. EGM Configuration parameter may be autoprogrammed to either V. Bipolar or V. Unipolar depending on the setting for the V. Pulse Configuration parameter.

High A. Rate Trigger

The High A. Rate Trigger parameter triggers an episode when the measured atrial rate exceeds the setting for a period longer than the number of Consecutive Cycles. This parameter becomes available when the High Atrial Rate setting for the Atrial Trigger parameter is chosen.

Settings: (min^{-1}) Off; 125; 150; 175; 200; 225; 250; 275; 300 (Nominal: Off)

Accessed From: Parameters button > Episodes Settings tab > Episode Triggers button > High Atrial Rate Atrial Trigger

Consecutive Cycles

The Consecutive Cycles parameter sets the number of high-rate cycles the device must count before an episode is recorded. This parameter becomes available when the High Atrial Rate setting for the Atrial Trigger parameter and/or the High V. Rate Trigger parameter are chosen.

Settings: 2; 3; 4; 5; 10; 15; 20 (Nominal: 5)

Accessed From: Parameters button > Episodes Settings tab > Episode Triggers button > High A. Rate Atrial Trigger or High Ventricular Rate Trigger

High V. Rate Trigger

The High V. Rate Trigger parameter triggers an episode when the measured ventricular rate exceeds the setting for a period longer than the number of Consecutive Cycles.

> NOTE: In Zephyr™ devices, if you enable the High V. Rate Trigger parameter, the V. Blanking parameter is autoprogrammed to 12 ms, and the V. Safety Standby parameter is autoprogrammed On.

Settings: (min^{-1}) Off; 125; 150; 175; 200; 225; 250; 275; 300 (Nominal: Off)

Accessed From: Parameters button > Episodes Settings tab > Episode Triggers button

PVC Trigger

The PVC Trigger parameter records an episode when the device counts a number of consecutive PVCs equal to or greater than the Consecutive PVCs parameter. For this trigger to be available, Mode must be programmed to either DDD(R) or VDD(R). (PVC Options does not have to be programmed On.)

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: Off; On (Nominal: Off)

Accessed From: Parameters button > Episodes Settings tab > Episode Triggers button

Consecutive PVCs

The Consecutive PVCs parameter sets the number of consecutive PVCs that must be counted before the PVC Trigger parameter stores an episode.

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: 2; 3; 4; 5 (Nominal: 2)

Accessed From: Parameters button > Episodes Settings tab > Episode Triggers button

Advanced Hysteresis Trigger

The Advanced Hysteresis Trigger parameter triggers an episode when the device detects a drop in the intrinsic rate that triggers the Intervention Rate algorithm (see Advanced Hysteresis Functions (page 38)). This trigger becomes available and is autoprogrammed On when the Intervention Rate parameter is enabled.

Settings: On; Off (Nominal: Off)

Accessed From: Parameters button > Episodes Settings tab > Episode Triggers button

PMT Detection Trigger

The PMT Detection Trigger parameter records an episode when the PMT Options algorithm detects a pacemaker-mediated tachycardia (PMT). For this trigger to be available, the PMT Options parameter must be programmed to either the 10 Beats > PMT or Auto Detect settings.

Available In: Sustain™ XL DC, DR; Victory™ DR; Zephyr™ DR Devices

Settings: On; Off (Nominal: Off)

Accessed From: Parameters button > Episodes Settings tab > Episode Triggers button

Magnet Placement Trigger

The Magnet Placement Trigger triggers an episode when a magnet is held over the device for at least one second[44].

See Magnet Response (page 35).

Settings: Off; On (Nominal: Off)

Accessed From: Parameters button > Episodes Settings tab > Episode Triggers button

[44] If Magnet Response is set to Battery Test and the magnet is held over the device for five seconds or more, a Battery Test begins.

Wrap-up™ Overview

Chapter contents:

Wrap-up™ Overview

The Wrap-up™ Overview window lists battery data, test status, and session programming changes as well as follow-up session management buttons, including:

- The **Session Notes panel**, which reports the status of routine follow-up tasks
- The **Selected Reports** button, which lists the reports that have been selected to print and opens the Reports window
- The **Restore Initial Values** button, which programs the device to the settings read at the beginning of the session
- The **Clear Diagnostics** button, which clears the episodes, diagnostics, or both from the device memory
- The **Export Data** button, which opens a window to export data to a USB device or PC
- The **Print Reports** button, which prints the reports listed in the Selected Reports button
- The **Clear After Printing** check-box, which automatically clears the selected diagnostics after printing

When the Wrap-up Overview button is pressed, the programmer updates the Battery & Leads data.

Accessed From: Wrap-up Overview button

Export Data

The Export Data window lists the devices that are currently connected to the programmer so that you can export a screen capture or patient-tracking database data.

To export data:

1. Insert the USB connector from a device into one of the six USB ports on the programmer.

   The device can be a USB flash drive or a PC connected to the Merlin™ 2 PCS through a 9-pin serial to USB connector cable.
2. Select the Export Data button.

   The programmer lists all connected devices.
3. Select the desired device. If a device hasn't been detected, select the Redetect Media button.
4. Select the Export button.

   The programmer checks the device and writes data to it. The Export Data window invoked from the Wrap-up Overview window closes after the data are exported. If data are exported from the Tools menu, you must select the Close button to return to the previous window.

Accessed From: Wrap-up Overview button > Export Data button

Clear Diagnostics

The Clear Diagnostics window clears diagnostics, episodes, or both from the device memory. Device data collected by the programmer during the session remains available until the End Session button is selected.

Select the Save Selections button to record your preferences for future programming sessions.

Accessed From: Wrap-up Overview button > Clear Diagnostics button

Restore Initial Values

The Restore Initial Values button reprograms the settings that were read at the initial interrogation. When you press the Program button, all parameter changes made during the session are lost.

Accessed From: Wrap-Up Overview button > Restore Initial Values button

Mode Descriptions

Abbott Medical pulse generators may be programmed to the following therapy modes. All modes can also be programmed to operate with rate-modulation (R). See Rate-Modulated Modes (page 67).

Table 15. Available Modes

Dual-Chamber	Atrial	Ventricular	Off Modes
DDD	AAI	VVI	ODO, OVO, and OAO
DDI	AAT	VVT	
DVI	AOO	VOO	
DOO			
VDD			

DDD

(Dual-Chamber Pacing, Sensing, and Inhibition; Atrial Tracking)

See DDD Mode timing diagram below.

The DDD Mode is a dual-chamber, atrial-based timing mode in which increases or decreases in the sensed atrial rate are duplicated by similar changes in the ventricular rate. Sensed P-waves or R-waves inhibit output pulses, while no intrinsic activity during the alert periods result in delivered pulses. There are four pacing states:

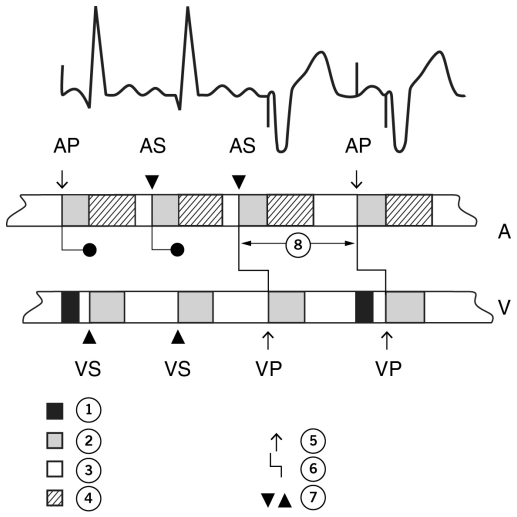
1. **AS.** A sensed atrial event (AS) inhibits an A. pulse and begins the Sensed AV Delay, and resets the device timing. The A. sense channel becomes refractory until the end of the A. Refractory Period (PVARP) while the V. channel becomes alert to R-waves.
2. **AP.** During the atrial alert period, no atrial sensed event is detected, and the device delivers an atrial pulse (AP) at the end of the alert period. This starts the Paced AV Delay, where the A. channel is refractory to atrial sensed events, while the V. channel becomes alert to R-waves.
3. **VS.** During the Paced/Sensed AV Delay, the V. channel senses a ventricular sensed event (VS) and inhibits the pulse but does not reset the timing. The V. Refractory Period and PVARP begin and continue until the periods time out. Then, both channels become alert to sensed events.
4. **VP.** The V. channel does not sense any signals during the Paced/Sensed AV Delay and delivers a ventricular pulse (VP) at the end of the delay. The V. Refractory Period and PVARP begin and continue until the periods time out. Then, both channels become alert to sensed events.

Indications. DDD operation is indicated in the presence of AV conduction disorders with normal or abnormal sinus node function and if the patient may benefit from a high degree of ventricular pacing.

Contraindications. DDD operation with Auto Mode Switch set to Off is contraindicated in the presence of chronic atrial tachyarrhythmias or silent atria. However, the device's Auto Mode Switch feature can automatically switch the device to DDI operation in the presence of atrial tachyarrhythmias. Retrograde conduction, though not a contraindication, requires the careful setting of the A. Refractory Period (PVARP) parameter.

NOTE: **Guaranteed atrial alert period.** At least 125 ms of the V-A interval is designated as a guaranteed atrial alert period to minimize competitive atrial pacing.

Figure 12. DDD Mode timing diagram



1. Blanking Period
2. Refractory Period
3. Alert Period
4. PVARP
5. Output Pulse
6. Paced/Sensed AV Delay
7. Sensed Event

DDI

(Dual-Chamber Pacing, Sensing, and Inhibition; No Atrial Tracking)

See DDI Mode timing diagram below.

The DDI mode is a non-tracking, dual-chamber mode in which sensed atrial activity does not cause a change in timing. Atrial tachycardias do not result in increased pacing rates. There are four pacing states:

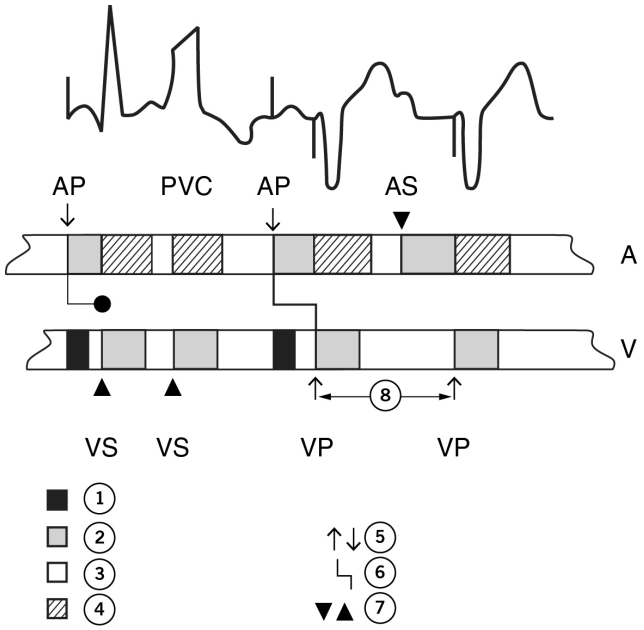
1. **AS.** A sensed atrial event (AS) inhibits the A. pulse and begins an atrial refractory period which ends at the V. pulse. The V. channel remains alert to R-waves except during the V. refractory period and after an A. pulse.
2. **AP.** During the atrial alert period, no atrial sensed event is detected, and the device delivers an atrial pulse (AP) at the end of the alert period. This starts the Paced AV Delay, where the A. channel is refractory to atrial sensed events. The V. channel remains alert to R-waves except during the V. refractory period and after an A. pulse.
3. **VS.** During the V. alert period of the Paced AV Delay, the channel detects a ventricular sensed event (VS), inhibits the pulse, and resets the timing. The V. Refractory Period and PVARP begin and remain in effect until the periods time out. Then, both channels become alert to sensed events.
4. **VP.** The V. channel does not detect a sensed event during the alert period or the Paced AV Delay and delivers a pulse (VP) at the end of the delay. The V. Refractory Period and PVARP begin and remain in effect until the periods time out. Then, both channels become alert to sensed events.

Indications. DDI operation is indicated in situations where dual-chamber pacing is required and there is a specific reason that atrial tracking is not desired.

Contraindications. DDI operation is contraindicated in AV block with normal sinus node function and silent atria and in AV block with chronic atrial fibrillation or flutter.

NOTE: Guaranteed atrial alert period. At least 125 ms of the V-A interval is designated as a guaranteed atrial alert period to minimize competitive atrial pacing.

Figure 13. DDI Mode timing diagram



1. Blanking Period
2. Refractory Period
3. Alert Period
4. PVARP
5. Output Pulse
6. Paced AV Delay
7. Sensed Event

DVI

(Dual-Chamber Pacing; Ventricular Sensing, Inhibition)

See DVI Mode timing diagram below.

The DVI mode is a dual-chamber mode in which sensed atrial activity is ignored, although the device can pace the atrium. The DVI mode has three states:

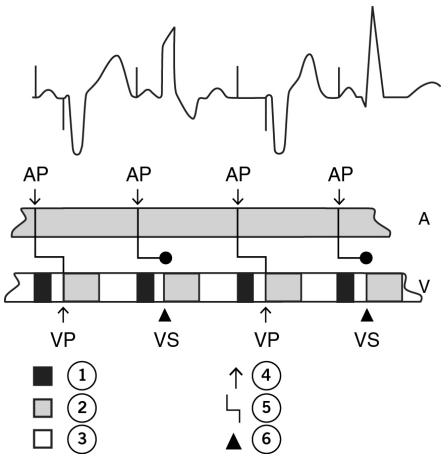
1. **AP.** At the end of the atrial escape interval, the device delivers an atrial pulse. This starts the Paced AV Delay, during which the V. channel remains alert to sensed events.

2. **VS.** During the Paced AV Delay, the V. channel detects a ventricular sensed event (VS), inhibits the pulse, and resets the timing. The V. Refractory Period begins and remains in effect until the periods time out. Then, the V. channel becomes alert to R-waves.
3. **VP.** The V. channel does not detect a sensed event during the Paced AV Delay and delivers a pulse (VP) at the end of the delay. The V. Refractory Period begins and continues until the period times out. Then, the V. channel becomes alert to R-waves.

Indications. DVI operation is indicated in situations where atrial and ventricular pacing are required and there is a specific reason that atrial sensing is not desired.

Contraindications. DVI operation is contraindicated in the presence of competitive intrinsic atrial rhythms or silent atria.

Figure 14. DVI Mode timing diagram



1. Blanking Period
2. Refractory Period
3. Alert Period
4. Output Pulse
5. Paced AV Delay
6. Sensed Event

DOO

(Dual-Chamber Asynchronous Pacing)

See DOO Mode timing diagram below.

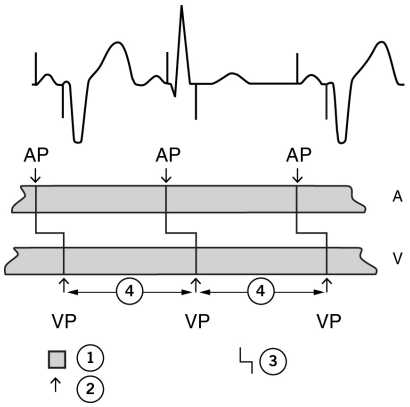
In DOO mode, the device paces in the atrium and ventricle at the programmed Base Rate and Paced AV Delay regardless of intrinsic activity.

> **CAUTION: DOO(R) mode is primarily intended for temporary use. Long-term use may result in competitive pacing, which may induce potentially dangerous tachyarrhythmias.**

Indications. DOO operation is indicated when there is a need for pacing in the atrium and ventricle with the likelihood that significant electromagnetic or electromyogenic noise could inappropriately inhibit or trigger the device.

Contraindications. DOO operation is contraindicated in the presence of competitive intrinsic cardiac rhythm.

Figure 15. DOO Mode timing diagram



1. Refractory Period
2. Output Pulse
3. Paced AV Delay

VDD

(Ventricular Pacing; Dual-Chamber Sensing and Inhibition; Atrial Tracking)

See VDD Mode timing diagram below.

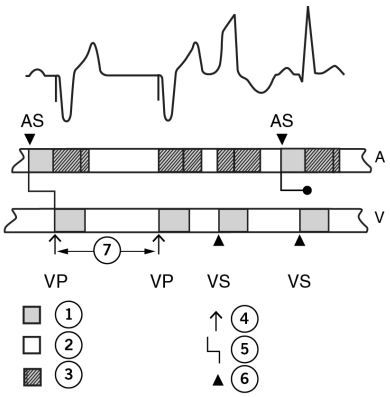
The VDD mode is a dual-chamber, atrial-tracking mode with no atrial output in which ventricular pacing is synchronized to intrinsic atrial activity. The device senses in both chambers but only paces in the ventricle. The mode maintains a minimum atrial alert window equal to the Sensed AV Delay + 25 ms (preferential P-wave sensing). The A. Refractory Period (PVARP) is shortened if other timing cycles infringe upon the atrial alert window. There are three pacing states:

1. **AS.** A sensed atrial event during the V-V interval initiates the Sensed AV Delay and may extend the V-V interval while AV synchrony is maintained. It is possible to track a sinus rhythm resulting in a rate lower than the programmed Base Rate.
2. **VS.** If the atrial channel detects a sensed event and the V. channel detects a sensed event during the Sensed AV Delay, the device resets the V-V timing.
3. **VP.** If no atrial and no ventricular events are sensed, the device paces the ventricle (VVI pacing).

Indications. VDD operation is indicated for AV block with normal sinus function.

Contraindications. VDD operation is contraindicated for sinus node dysfunction, chronic atrial flutter or fibrillation, inadequate atrial sensing, or silent atria.

Figure 16. VDD Mode timing diagram



1. Refractory Period
2. Alert Period
3. PVARP
4. Output Pulse
5. Paced AV Delay
6. Sensed Event

VVI

(Ventricular Pacing, Sensing, and Inhibition)

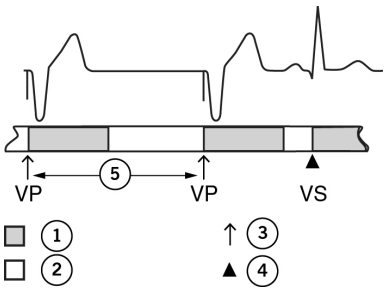
See VVI Mode timing diagram below.

In VVI mode, the device paces the ventricle at the programmed rate if it does not detect a sensed event. If the device detects a sensed event during the alert period, it withholds the pulse and it resets the timing period to the start of the Ventricular Refractory Period.

Indications. VVI operation is indicated for symptomatic bradycardia of any etiology. This includes, but is not limited to, AV block or sinus node dysfunction and the various manifestations of sinus node dysfunction, including sinus node arrest, sinus bradycardia, and brady-tachy syndrome.

Contraindications. VVI operation is contraindicated in the presence of pacemaker syndrome.

Figure 17. VVI Mode timing diagram



1. Refractory Period
2. Alert Period
3. Output Pulse
4. Sensed Event

VVT

See VVT Mode timing diagram below.

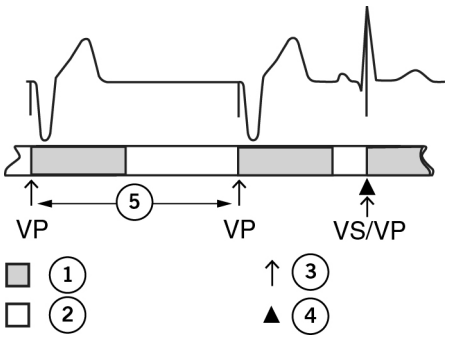
(Ventricular Pacing, Sensing, and Triggering)

In VVT mode, the device paces the ventricle at the programmed rate in the absence of ventricular sensed events. If the device detects a sensed event during the alert period, it delivers a pulse synchronously with the sensed event.

Indications. VVT may be useful to avoid inappropriate pulse inhibition resulting from electromagnetic or electromyogenic interference. VVT operation can also be used to identify the sensing site within a complex and to evaluate and manage arrhythmias elicited by chest wall stimulation.

Contraindications. VVT operation is contraindicated in the presence of pacemaker syndrome.

Figure 18. VVT Mode timing diagram



1. Refractory Period
2. Alert Period
3. Output Pulse
4. Sensed Event

VOO

See VOO Mode timing diagram below.

(Ventricular Asynchronous Pacing)

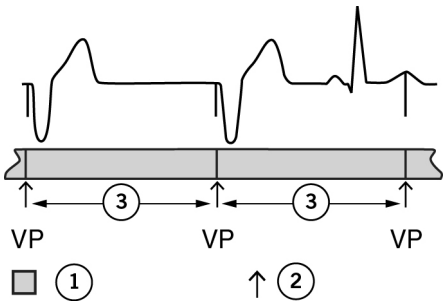
In VOO mode, the device paces the ventricle at the programmed rate regardless of the intrinsic rhythm.

> **CAUTION: VOO(R) mode is primarily intended for temporary use. Long-term use may result in competitive pacing, which may induce potentially dangerous ventricular tachyarrhythmias.**

Indications. VOO operation may be indicated for patients who are subject to electromagnetic interference or electromyogenic noise and who need continual ventricular pacing.

Contraindications. VOO operation is contraindicated in patients who have a competitive intrinsic cardiac rhythm and who have or are likely to experience pacemaker syndrome during single-chamber ventricular pacing.

Figure 19. VOO Mode timing diagram



1. Refractory Period
2. Output Pulse
3. Programmed Rate

AAI

See AAI Mode timing diagram below.

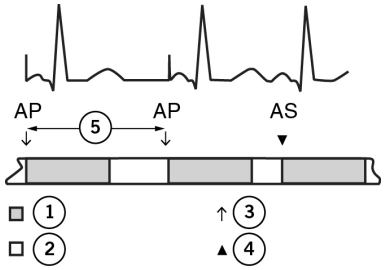
(Atrial Pacing, Sensing, and Inhibition)

In AAI mode, the device paces the atrium at the programmed rate if the atrial events are not sensed. If the device detects a sensed event during the alert period, it withholds the pulse and resets the timing to the start of the Atrial Refractory Period.

Indications. AAI operation is indicated for symptomatic bradycardia caused by sinus node dysfunction.

Contraindications. AAI operation is contraindicated in the presence of AV conduction disorders, chronic atrial fibrillation, or atrial flutter.

Figure 20. AAI Mode timing diagram



1. Refractory Period
2. Alert Period
3. Output Pulse
4. Sensed Event
5. Programmed Rate

AAT

See AAT Mode timing diagram below.

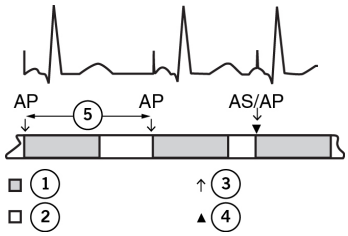
(Atrial Pacing, Sensing, and Triggering)

In AAT mode, the device paces the atrium at the programmed rate in the absence of atrial sensed events. If the device detects a sensed event during the alert period, it delivers a pulse synchronously with the sensed event.

Indications. AAT may be useful to avoid inappropriate pulse inhibition resulting from electromagnetic or electromyogenic interference. AAT operation can also be used to identify the sensing site within a complex and to evaluate and manage arrhythmias elicited by chest wall stimulation.

Contraindications. AAT operation is contraindicated in the presence of AV conduction disorder, atrial fibrillation, or atrial flutter.

Figure 21. AAT Mode timing diagram



1. Refractory Period
2. Alert Period
3. Output Pulse
4. Sensed Event
5. Programmed Rate

AOO

See AOO Mode timing diagram below.

(Atrial Asynchronous Pacing)

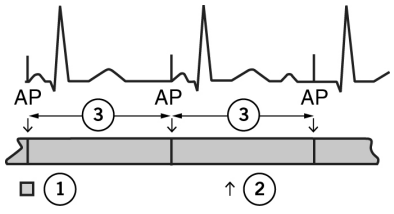
In AOO mode, the device paces the atrium at the programmed rate regardless of intrinsic rhythm.

> **CAUTION: AOO(R) mode is primarily intended for temporary use. Long-term use may result in competitive pacing, which may induce potentially dangerous atrial tachyarrhythmias.**

Indications. AOO operation may be indicated for patients who are subject to electromagnetic interference or electromyogenic noise and who need continual atrial pacing.

Contraindications. AOO operation is contraindicated in the presence of competitive intrinsic cardiac rhythm or AV conduction disorders.

Figure 22. AOO Mode timing diagram



1. Refractory Period
2. Output Pulse
3. Programmed Rate

ODO, OVO, and OAO

CAUTION: ODO, OVO, or OAO modes are not recommended for pacemaker-dependent patients or patients who might be affected by even a short cessation of the device's operation.

In these modes, pacing is turned off while the device continues to detect and record sensed events. These modes are useful primarily for temporary diagnostic evaluation and recording of intrinsic activity. When these modes are programmed, the programmer does not show Markers or the measured rate. The programmer displays EGMs.

These modes are not available when Sensor in programmed On.

Rate-Modulated Modes

The function of rate-modulated modes (Sensor On) is to alter the pacing rate to match activity changes in accordance with programmed parameters. Rate-modulation can be enabled with any mode. For more information on Sensor programming, see Sensor (page 36).

Indications. Indications for rate-modulated modes are the same as those without rate-modulation, except that rate-modulated modes are further indicated when an increase in pacing rate with activity is desired.

Contraindications. Contraindications for rate-modulated modes are the same as those without rate modulation, except that rate-modulated modes are also contraindicated when pacing rates above the programmed Base Rate may not be well tolerated.

Additional Programming Information

Chapter contents:

Technical Support

Abbott Medical maintains 24-hour phone lines for technical questions and support:

- 1 818 362 6822
- 1 800 722 3774 (toll-free within North America)
- + 46 8 474 4147 (Sweden)
- + 61 2 9936 1200 (Australia)
- medical.abbott/manuals

For additional assistance, call your local Abbott Medical representative.

Bradycardia Devices

Refer to the Merlin™ 2 PCS Start-Up Reference Manual for a list of all bradycardia devices that can be interrogated by the Merlin 2 PCS equipped with Model MER3400 software.

The pulse generators listed in the table below are discussed in this help system. Older bradycardia devices are discussed in the Merlin PCS Bradycardia Devices Reference Manual.

NOTE: If you do not know the implanted device's model name or number, interrogate the device without the magnet.

Table 16. Bradycardia devices discussed in this help system

Device	Model Number
Sustain™ XL DC	PM2134
Sustain XL DR	PM2136
Sustain XL SC	PM1134
Sustain XL SR	PM1136
Victory™ XL DR	5816
Victory DR	5810
Victory SR	5610
Zephyr™ XL DR	5826
Zephyr DR	5820
Zephyr XL SR	5626
Zephyr SR	5620

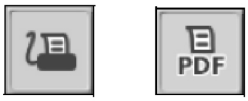
Main Programming Window

The Main Programming window is the upper portion of the screen that contains the following buttons:

- **? Button.** Opens the on-screen Help menu.
- **Tools menu.** Opens a menu for the PSA application (nonfunctional), preferences, and other functions.
- **Patient Data.** Opens a window to write and edit patient information into the device memory.
- **Note.** Opens a window for additional patient data.
- **Measured Heart Rate.** Shows the currently measured rate.

- **Rhythm Display.** Shows the real-time waveforms.
- **Adjust Display button.** Opens a window to adjust the Rhythm Display.
- **Freeze Capture button.** Freezes the Rhythm Display and opens a window to adjust and print the freeze.
- **Print Settings button.** Opens the Print Settings window. An icon with a cord indicates the programmer is connected to an external printer (see figure below). The "PDF" icon indicates that paperless (PDF) printing is selected. See PDFs (page 1). To change printers, select Tools > Preferences > Printer (Printer Preferences).

Figure 23. Printer icons: 1. (left) external printer connected; 2. (right) paperless or PDF printing selected



Device Parameters and Settings Selection

To change the setting for any parameter, touch the desired parameter button. A setting selection window appears. If all settings cannot fit on the screen, use the up and down arrows to view additional settings. The overall range of settings is usually indicated at the top and bottom of the window. The current permanently programmed setting is marked with a small pacer icon.

Select the desired setting. This stores the setting in the programmer's memory (or "batch-stores" the setting); it does not program the parameter. For the new setting to take effect, select the Program or Start Temporary buttons.

Once a setting has been selected, the setting selection window disappears. To leave the setting selection window before a new setting is stored, close the window.

Batch Storing and Autoprogramming

The programmer can store several parameter settings in a "batch" in memory before they are permanently or temporarily programmed (or canceled). When you change a parameter setting, the color of the parameter button changes to green, as do the buttons of all "autoprogrammed" parameters. This indicates that the setting has been stored for programming later. The Program and Preview buttons are highlighted. The Preview button displays a number indicating the number of parameters that are ready for permanent programming.

Once a setting is batch-stored, you can select the following buttons:

- **Program** permanently programs the setting.
- **Preview Changes** opens the Preview window containing the manually selected and autoprogrammed settings.
- **Discard Changes** on the Preview window removes the changes from memory.
- **Start Temporary** temporarily programs the settings.

Preview Changes

The Preview Changes window lists all parameters and settings selected for programming. It also contains the:

- **Discard Changes** button to reject all proposed parameter changes
- **Program** button to permanently program the listed parameters
- **Start Temporary** button to temporarily program the listed parameters

Start Temporary

When the Start Temporary button is selected from the Preview Changes window, the Discard Changes button disappears, the green highlights turn orange, and the device operates with those settings in effect until the:

- **Cancel Temporary** button is selected, which restores all permanently programmed settings and re-opens the Preview Changes window or
- The **Program** button is selected, which permanently programs the temporary settings.

If telemetry is lost while temporary settings are programmed, the device operates at its permanently programmed settings. The programmer prompts you to either continue or end the session. If telemetry was lost inadvertently, select the Continue button when the wand is over the device.

You can also temporarily program many parameters with the Temporary Pacing window.

Emergency Operation

The console has two emergency option buttons:

- **Shock.** Select this button to show the Shock screen (not supported for bradycardia devices).
- **VVI.** Select this button to automatically reset the device to predefined high-output settings[45].

[45] Emergency VVI settings for each device are listed in the Technical Data appendixes for each device.

Print Menu

The Print Menu window contains two tabs:

- **Reports** (page 71)
- **Settings** (page 72)

Reports

The Reports window allows you to select or deselect any report in the print queue, to configure the report, and to print all selected reports.

To change the data printed in the Summary, Test, or Wrap-up reports or to view the episodes or frozen rhythm displays, select the blue button on the right.

To select a report to print, select the check-box on the left.

Up to five report types are available:

- **Summary Report.** Select the blue button to open the Summary Report Settings window to change the print options. A full Summary Report can include all FastPath™ Summary Screen information, all current parameter settings, all diagnostics, all episode settings, a listing of each episode, and a Rhythm Display Freeze Capture taken at the time of the printing.
- **Episodes.** Select the blue button to open the Episode Directory window. You can print every episode or selected episodes.
- **Test Results.** Select the blue button to open the Test Result Settings window to change the print options. The report contains Rhythm Display and data from all Tests performed.
- **Freeze.** Select the blue button to open the Freeze Capture window. The report prints every Freeze Capture selected for printing.
- **Wrap-up™ Report.** Select the blue button to open the Wrap-up Report Settings window to change the print options. Based on the settings, the Wrap-up Report can include the Wrap-up Overview window information and all current parameter settings.

Accessed From: Print button > Reports tab

Summary Report Settings

The Summary Report Settings window allows you to change the contents of the information in the Summary Report. There are three check-boxes:

- **Include Extended Diagnostics.** Select this check-box to add the following data to the Summary Report:
  - Rates. A table showing the percentage of total times for each event by different rate-range bins for the Heart Rate Histogram and Events summaries.
  - AMS Summary. The total number of AMS episodes in each rate range[46].
  - AMS Log. All Log entries (only key AMS Log episodes are included if the box is not checked).
  - AT/AF Summary. The total number of AT/AF episodes in each rate range[47].
  - AT/AF Log. All Log entries (only key AT/AF Log episodes are included if the box is not checked).
  - AT/AF Burden Trend. The actual number and duration of AT/AF episodes for each week.
  - AF Suppression™. A table showing the percentage of time the device was in AS or AP states (AF Suppression™-driven pacing) for each rate-range bin[48].
- **Include Presenting Rhythm Freeze.** Select this check-box to add a printout of the Freeze Capture data taken at initial interrogation.
- **Save These Settings.** Records your preferences for future programming sessions

Accessed From: Print button > Reports tab > Summary Report button

Test Results Settings

The Test Result Settings window sets the size of the test results printout and allows you to limit the number of large test printouts to one per session.

There are two radio buttons:

- **Small Freezes** radio button allows you to place up to four test results per page.
- **Large Freezes** radio button allows you to place up to two test results per page.

The **Save These Settings check-box** records your preferences for future programming sessions.

There are two check-boxes:

Include Capture and Sense check-box prints Capture & Sense test results, AutoCapture™ Trend (see the Follow-up EGM V. Capture Test tab (page 17) and Follow-up EGM (page 22)) and Amplitude Trend (see the Follow-up EGM Sense Test tab (page 26)), and follow-up EGMs (if the Amplitude Monitoring parameter is On).

Include Battery & Leads check-box prints data from the Battery & Leads window (battery voltage, current, and impedance, Magnet Rate, remaining longevity) and from the Lead Impedance window (lead impedance measurements and impedance trends (if the Lead Monitoring Parameter is enabled).

Accessed From: Print button > Reports tab > Test Results button

Wrap-up™ Report Settings

The Wrap-up™ Report Settings window allows you to change the amount of information in the Wrap-up report.

[46] To print the AMS diagnostics, the Auto Mode Switch parameter must be enabled or A. Trigger must be set to AMS.
[47] To print the AT/AF Histograms window, the A. Trigger parameter must be set to AT/AF.
[48] To print the AF Suppression diagnostics, the AF Suppression parameter must be On.

There are three check-boxes:

- **Include Full Parameters Report.** Select this check-box to print out the initial and present settings for all programmed parameters. When this box is not checked, only the data on the Wrap-up Overview screen are printed.
- **Print Second Copy for Patient.** Select this check-box to print an additional Wrap-up Report copy.
- **Save These Settings.** Records your preferences for future programming sessions.

Accessed From: Print button > Reports tab > Wrap-up Report button

Settings

The Settings window allows you to set print preferences.

Select the Printer Preferences button to change the report destination (PDF Only or External & PDF) and the number of copies of the report.

Select the appropriate check-mark boxes to:

- Add the **patient's name and ID** to the printed report headers. The information comes from the device's memory that can be viewed in the Patient Data window.
- Add the **Clinic Name** to the printed report header. Select the blue button to open the on-screen keyboard to enter the information into the programmer's memory.
- Automatically print the **Summary Report** on initial interrogation. See Reports (page 71).

Accessed From: Wrap-Up Overview button > Selected Reports button > Settings tab or Main Programming window > Print Menu button > Settings tab

Backup VVI

In rare instances, the device may revert to Backup VVI operation at the programmed settings listed in the table below. These settings are not programmable.

Table 17. Backup VVI settings

Parameter	Setting
Mode	VVI
Base Rate	67.5 min^{-1}
Pulse Configuration	Unipolar
Sense Configuration	Unipolar Tip
Pulse Amplitude	4.0 V minimum
Pulse Width	0.6 ms
Refractory	335 ms
Sensitivity	2.0 mV

When the device reverts to Backup VVI operation, the programmer shows a pop-up message that indicates that the device is in Backup VVI. Press the Continue button and follow the on-screen instructions.

Under most conditions, the previously programmed settings can be restored. The programmer executes a short routine (approximately five minutes) to restore the previously programmed settings. When the routine is complete, the programmer prints a Device Status Report. Return this report to the Abbott Medical location indicated on the report. Perform the normal follow-up tests and review the restored parameter settings.

If the routine cannot restore the programmed settings, contact Abbott Medical Technical Support (page 69).

Elective Replacement Indicator (ERI)

ERI (used synonymously with RRT) is the point at which the battery voltage can only maintain adequate operation for a nominal period of three months before End-of-Life (EOL).

When the device exhibits signs of ERI, described below, replace it expeditiously. There are a number of indicators to this condition:

- The pacing interval increases by 100 ms over the Base Rate to reduce current drain (The difference between the programmed Base Rate and actual pacing rates at ERI are found in the table below.
- The programmer displays an alert that the device has detected ERI.
- The Battery & Leads window displays a Clear ERI button.
- AF Suppression™* and Sensor* are programmed Off.
- The battery voltage decreases to 2.5 V.
- The battery impedance increases.
- The Magnet Response is automatically programmed to Battery Test.
- The Magnet Rate measures approximately 86.3 min^{-1} or less.
- The Shortest AV Delay* is programmed to 70 ms.
- The Shortest PVARP/VREF* is programmed to 200 ms.
- The V. AutoCapture is programmed to Off (the V. Pulse Amplitude is reset to twice the average of the previous four capture threshold measurements up to a maximum of 5.0 V and a minimum of 2.0 V).

- The ACap™ Confirm Parameter* parameter is programmed Off. If the parameter is On, the device sets the A. Pulse Amplitude to twice the average of the last four threshold measurements up to 5.0 V, with a minimum of 2.0 V. If the parameter is set to Monitor, no adjustment is made to the A. Pulse Configuration.
- The following features no longer operate at ERI:
  - Rest Rate*
  - Diagnostics data collection[49]
  - NIPS
  - Stored EGMs in the Episode Directory window

* Not available in all devices

Clear ERI

Select the Clear ERI button from the Battery & Leads window if you suspect that ERI is premature. ERI may be artificially reported under such conditions as extreme cold temperatures, abnormally high output and high rate settings, or exposure to EMI sources such as electrocautery and defibrillation.

To clear ERI, select the Clear ERI button. To verify that the ERI was premature, remove the telemetry wand from the device, then replace it. If the ERI message was true, then the ERI message appears again[50].

WARNING: At ERI, the nominal life of the device is approximately three months. The device should be replaced expeditiously.

CAUTION: High output settings or high rates may shorten the time to ERI. If the programmer shows an ERI warning message, fully evaluate the device.

NOTE: **Autoprogrammed Parameters.** The programmed parameters that were autoprogrammed at ERI are not restored to their initial settings when Clear ERI is selected. Interrogate and reprogram the device.

Episodes. At ERI, all Episodes are cleared and the device is reprogrammed to Event Recording[51].

Table 18. Programmed pacing rates and actual pacing rates (in min^{-1}) at ERI

Programmed Rate	Actual Rate at ERI (100 ms Interval Increase)	Programmed Rate	Actual Rate at ERI (100 ms interval increase)
45	41.9	110	93.0
50	46.2	115	96.5
55	50.4	120	100.0
60	54.5	125	103.4
65	58.6	130	106.8
70	62.7	135	110.2
75	66.7	140	113.5
80	70.6	145	116.8
85	74.4	150	120.0
90	78.3	155	123.2
95	82.0	160	126.3
100	85.7	165	129.4
105	89.4	170	132.5

End-of-Life

When the device's output pulse amplitude drops to 50% of its programmed setting, the device has reached End-of-Life (EOL). Typically, this occurs when the battery voltage has fallen to below 2.0 V. Refer to the appropriate User's Manual for specific information on EOL conditions.

A Magnet Rate of 66 min^{-1} indicates EOL. For more information, see Magnet Response (page 35).

[49] With the exception of average measured battery voltage, current, and lead monitoring.
[50] If the battery voltage is between 2.5 and 2.35 V, the ERI alert warning may be delayed by 23 hours. Contact Abbott Medical Technical Support.
[51] Event Records cannot be viewed on a Merlin™2PCS programmer.

Error and Informational Messages

Help

The Help function provides context-sensitive information on programmer and device functions.

When you select the ? button during a session, a Small Help window containing context-sensitive information appears. You can:

- Scroll down the page
- Select the "See More" button to view the information in the large Help window with a Table of Contents, Index, and Search function
- Select the "Search" button to open the Search function in the large Help window

The Large Help window contains:

- Icons for three navigation buttons (Back, Forward, Home) and a Print button
- Tabs for a Table of Contents, an Index, and a Search function
- A topic window with active hyperlinks to other topics.

Print. Select the Print icon to print entire topic.

Search. To search for a specific term, select the Search tab. Then, select the on-screen keyboard icon on the Search button. Type the search term and select the Done button. The Search tab opens with a list of all the entries containing the term.

Table of Contents and Index. Select an entry to display the topic.

Problem with Media Device

The media device is not functioning properly because the device is damaged, is not recognized by the programmer, or is busy.

The programmer can communicate only with USB flash drives and serial port adapters. Contact your Abbott Medical representative or Technical Support (page 69) for a list of devices that are compatible with the Merlin™ 2 PCS.

No Media Detected

Reasons for this error message include:

- The media device is not supported by the programmer. Contact your Abbott Medical representative or Technical Support (page 69) for a list of supported devices.
- The USB port is not functioning. Use another port.
- The device connector is not fully inserted into the port.

Media Invalid or Not Present

Reasons for this error message include:

- The device connector is not fully inserted into the port.
- The media device is full. Select another device or erase enough data to allow room for the file and try again.
- The media device is write-protected or lacks proper read/write permission. Select another device or remove the write-protection or obtain permission and try again.
- The patient-tracking software or the destination PC is not operating. Reboot the PC and restart the patient-tracking software.
- The USB port is not functioning. Use another port.
- The cable for the serial connection is not functioning. Check or replace the cable.

Sustained Interruption

The programmer has tried unsuccessfully to interrogate the device for 15 minutes and has stopped interrogation.

Reasons for this message include:

- The wand is out of range of the device.
- The wand was removed from the programmer.
- Other electronic equipment in the area is interfering with the telemetry.

Either select the End Session button or correct any problem and select the Continue Session button.

Device Not Supported

The programmer was unable to communicate with the device because it is not supported or could not be identified. Attempt to interrogate the device with a Model 3650 programmer.

Telemetry Interruption

Telemetry between the device and the programmer was interrupted.

Reasons for this message include:

- The wand is out of range of the device.
- The wand was removed from the programmer.
- A magnet has been placed in the wand.
- Other electronic equipment in the area is interfering with the telemetry.

Correct any problem and select the Interrogate button.

Episodes Not Supported

This device does not support episode recording. However, the device does support Event Records. To view Event Records, interrogate the device with a Model 3650 programmer.

Episodes Collection Disabled

The device cannot set the ECG configuration or gain when one or more leads is uncoded. Set the Lead Type to either Unipolar, Bipolar, or Uni/Bi.

Diagnostics Cannot Be Cleared or Retrieved

The diagnostics could not be cleared or retrieved because the telemetry between the device and the programmer was interrupted.

Reasons for this message include:

- The Link Module is disconnected from the programmer.
- The patient cable is disconnected from the Link Module.
- The electrodes are not placed accurately on the patient.
- Other electronic equipment in the area is interfering with the telemetry.

Correct any problem and select the Continue Session button.

Programming Interrupted

The device could not be programmed because the telemetry between the device and the programmer was interrupted.

Reasons for this message include:

- The wand is out of range of the device.
- The wand was removed from the programmer.
- A magnet has been placed in the wand.
- Other electronic equipment in the area is interfering with the telemetry.

Correct any problem and select the Program button.

Temporary Programming Interrupted

The device could not be temporarily programmed because the telemetry between the device and the programmer was interrupted.

Reasons for this message include:

- The wand is out of range of the device.
- The wand was removed from the programmer.
- A magnet has been placed in the wand.
- Other electronic equipment in the area is interfering with the telemetry.

Correct any problem and select the Continue Session button.

Test Interrupted

The test was canceled because the telemetry between the device and the programmer was interrupted.

Reasons for this message include:

- The wand is out of range of the device.
- The wand was removed from the programmer.
- A magnet has been placed in the wand.
- Other electronic equipment in the area is interfering with the telemetry.

Correct any problem and select the Continue Session button.

Test Cannot Start

The test cannot start because the telemetry between the device and the programmer was interrupted.

Reasons for this message include:

- The wand is out of range of the device.
- The wand was removed from the programmer.
- A magnet has been placed in the wand.
- Other electronic equipment in the area is interfering with the telemetry.

Correct any problem and select the Continue Session button.

Reset Auto Threshold Not Complete

The procedure could not finish because the telemetry between the device and the programmer was interrupted.

Reasons for this message include:

- The wand is out of range of the device.
- The wand was removed from the programmer.
- A magnet has been placed in the wand.
- Other electronic equipment in the area is interfering with the telemetry.

Select the Close button and re-establish telemetry.

Battery & Leads Not Available in Off Modes

Battery & Leads information cannot be updated while the device is programmed to ODO, OVO, or OAO modes because an emitted pulse is required. For more information, see ODO, OVO, and OAO (page 67).

Specify Lead Type\Leads Uncoded

The Lead Type parameter must be specified to program a number of parameters, including Sense Configuration, Pulse Configuration, ACap™ Confirm Parameter, and V. AutoCapture™.

To program the V. AutoCapture parameter, set the Lead Type parameter to Uni/Bi. (The Zephyr™ device can operate the V. AutoCapture parameter using either the Uni/Bi, Bipolar Only, or Unipolar Lead Types.)

To program the ACap Confirm parameter, set the Lead Type parameter to either Uni/Bi or Bipolar Only.

Invalid Parameters Detected

The programmer detected invalid parameter(s), which also invalidates the recorded diagnostics and episodes.

Selecting the Program Nominals button institutes standard or nominal settings in the device. For a list of nominal settings, see Sustain™ Devices Technical Data (page 79), Victory™ Devices Technical Data (page 89), or Zephyr™ Devices Technical Data (page 99).

Perform V. AutoCapture Setup

If you change any of these parameters, you can change how the device measures evoked response. This could result in improper sensing of a captured beat.

To ensure that all V. AutoCapture™ related settings are correct, run the V. AutoCapture Setup test. Select the Tests tab > Ventricular Capture Test > AutoCapture Setup.

Perform ACap™ Confirm Setup

Changing either the A. Pulse Width or ACap™ Confirm Parameter setting can alter how the device measures evoked response and could result in improper detection of a captured beat.

To ensure that all ACap Confirm-related settings are correct, run the ACap Confirm Setup test. Select the Tests tab > Atrium Capture Test > AutoCapture Setup.

Lead Type for V. AutoCapture

To operate the V. AutoCapture™ parameter, the V. Lead Type setting must be set to accommodate the required settings for the V. Pulse Configuration and V. Sense Configuration parameters. Please set the V. Lead Type to the correct setting listed in the table below for the device model.

Table 19. Settings required for V. AutoCapture by device model

Device	V. Pulse Configuration	V. Sense Configuration	Lead Type Setting
Sustain™	Unipolar	Unipolar or Bipolar	Uni/Bi
Victory™ DR, SR	Unipolar	Unipolar or Bipolar	Uni/Bi
Zephyr™ DR, SR	Unipolar or Bipolar	Unipolar or Bipolar	Uni/Bi, Bipolar Only, or Unipolar

Lead Type Settings for ACap™ Confirm

The ACap™ Confirm Parameter function requires that the A. Pulse Configuration parameter be set to Bipolar. To set this configuration, you must first program the A. Lead Type parameter to either Uni/Bi or Bipolar Only. Select the View Leads button to change the Lead Type setting and then program the ACap Confirm parameter to On or Monitor. Select the Cancel button if you do not wish to operate the ACap Confirm function.

Pacing Configuration for ACap™ Confirm

The ACap™ Confirm Parameter function requires that the A. Pulse Configuration parameter be set to Bipolar. Select the Continue button to store the A. Pulse Configuration setting to Bipolar for later programming. Select the Cancel button if you do not wish to change the Pulse Configuration setting or to operate the ACap Confirm function.

Pacing/Sensing Configurations for V. AutoCapture

In some devices (see table below), V. AutoCapture™ requires that the V. Pulse Configuration parameter be set to Unipolar and the V. Sense Configuration parameter be set to Bipolar. Configurations in Sustain™, Victory™, and Zephyr™ devices may be set differently. Programming V. AutoCapture On will automatically change the pacing and/or sensing configuration so that AutoCapture can operate correctly.

Press Continue to reprogram the pacing and/or sense configuration.

Press Cancel to return V. AutoCapture to Off.

Table 20. Settings required for V. AutoCapture by device model

Device	V. Pulse Configurations	V. Sensor Configuration	Lead Type Setting

Table 20. Settings required for V. AutoCapture by device model

Device	V. Pulse Configurations	V. Sensor Configuration	Lead Type Setting
Sustain	Unipolar	Unipolar or Bipolar	Uni/Bi
Victory DR, SR	Unipolar	Unipolar or Bipolar	Uni/Bi
Zephyr DR, SR	Unipolar or Bipolar	Unipolar or Bipolar	Uni/Bi, Bipolar Only, or Unipolar

AutoCapture Setup Test Incomplete

The test could not complete because the programmer could not:

- Collect enough Evoked Response and/or Polarization values to complete the test.
- Increase the rate above the Max Track Rate or Max Sensor Rate
- Communicate with the device because of electromagnetic interference.

On-Screen Keyboard

Use the On-Screen Keyboard to enter data.

- **Special Char key.** Select this key and then select the key to display the special character (labeled in green on the key).
- **Inactive Keys.** If the device memory does not support a character, the key may be displayed on the keyboard but it is not active.
- **Repeating Keys.** If you press and hold most keys on the on-screen keyboard, they are not continually typed. The exceptions are the arrow keys, the Space key, the Enter key, and the Backspace key.
- **External Keyboard.** You can use an external keyboard connected to the programmer through any of its USB ports.

Emergency VVI Programming Interrupted

Emergency VVI programming cannot start because the telemetry between the device and the programmer was interrupted.

Reasons for this message include:

- The wand is out of range of the device.
- The wand was removed from the programmer.
- A magnet has been placed in the wand.
- Other electronic equipment in the area is interfering with the telemetry.

Correct any problem and select the Continue Session button or contact Technical Support for more information (page 69).

Backup VVI Procedure Interrupted

The Backup VVI procedure could not complete because the telemetry between the device and the programmer was interrupted.

Reasons for this message include:

- The wand is out of range of the device.
- The wand was removed from the programmer.
- A magnet has been placed in the wand.
- Other electronic equipment in the area is interfering with the telemetry.

Correct any problem and select the Continue button or contact Technical Support for more information (page 69).

Test Cannot Be Run

The starting setting for the test is at its maximum or minimum and cannot be increased or decreased. Reset the starting setting and restart the test.

Requires Connection to Computer

Before you can export the data to a computer database, you must connect the computer's serial port to a USB port on the Merlin™ 2 PCS using a USB-to-serial adapter. Contact Technical Support for more information (page 69).

BVVI Session Must Be Ended

You have chosen to cancel the Backup VVI procedure. If you wish to attempt the procedure again, re-interrogate the device. Do not remove the wand until all error messages have been removed. Contact Technical Support for more information (page 69).

Unable to Restore Original Parameters

An error has occurred during the restoration of new pacer software, and the Backup VVI procedure cannot be completed. Contact Technical Support for more information (page 69).

Appendix A. Sustain™ Devices Technical Data

The technical data below include:

Sustain™ Dual-Chamber Devices (Models PM2134, PM2136)

Shipped, Emergency VVI, and Standard Settings

Table 21. Shipped, Emergency VVI, and Standard settings for Sustain Dual-Chamber Devices (Models PM2134, PM2136)

Parameter	Shipped Settings	Emergency VII Settings	Standard (Nominal) Settings[52]
Basic Operation			
Mode	DDD	VVI	DDD
Magnet Response	Battery Test	Battery Test	Battery Test
Sensor *	Passive	Off	Passive
Max Sensor Rate *	130 min^{-1}	No Change	130 min^{-1}
Threshold*	Auto (+ 0.0)	No Change	Auto (+ 0.0)
Slope *	Auto (+ 2)	No Change	Auto (+ 2)
Reaction Time *	Fast	No Change	Fast
Recovery Time *	Medium	No Change	Medium
Rates			
Base Rate	60 min^{-1}	70 min^{-1}	60 min^{-1}
Rest Rate *	Off	Off	Off
Max Tracking Rate	130 min^{-1}	-	130 min^{-1}
Hysteresis Rate	Off	Off	Off
Search Interval	-	-	Off
Cycle Count	-	-	1
Intervention Rate	-	-	Off
Intervention Duration	-	-	3 min
Recovery Time	-	-	Medium
Delays			
Paced AV Delay	200 ms	-	200 ms
Sensed AV Delay	150 ms	-	150 ms
Rate Responsive AV Delay	Off	-	Off
Shortest AV Delay	100 ms	-	100 ms
Ventricular Intrinsic Preference (VIP™)	Off	-	Off
VIP Search Interval	-	-	1 min
VIP Search Cycles	-	-	1 cycle
Negative AV/PV Hysteresis w/Search	Off	-	Off
Capture & Sense			
V. AutoCapture™	Off	Off	Off
A. Pulse Amplitude	2.5 V	-	2.5 V
V. Pulse Amplitude	2.5 V	7.5 V	2.5 V
A. Pulse Width	0.4 ms	-	0.4 ms
V. Pulse Width	0.4 ms	0.6 ms	0.4 ms

[52] If parameters have not been previously programmed and are not autoprogrammed, the device will institute these standard or nominal settings.

Table 21. Shipped, Emergency VVI, and Standard settings for Sustain Dual-Chamber Devices (Models PM2134, PM2136)

Parameter	Shipped Settings	Emergency VII Settings	Standard (Nominal) Settings[52]
A. Amplitude Monitoring	On	No Change	On
V. Amplitude Monitoring	On	No Change	On
A. Sensitivity	0.5 mV	-	0.5 mV
V. Sensitivity	2.0 mV	2.0 mV	2.0 mV
Backup Pulse Configuration	-	-	Bipolar
Search Frequency	-	-	8 hrs
Leads			
A. Lead Type	Uncoded	No Change	Uncoded
V. Lead Type	Uncoded	No Change	Uncoded
A. Pulse Configuration	See Package Label	-	See Package Label
V. Pulse Configuration	See Package Label	Unipolar[53]	See Package Label
A. Sense Configuration	See Package Label	-	See Package Label
V. Sense Configuration	See Package Label	Unipolar Tip[54]	See Package Label
A. Lead Monitoring	Off **	-	Off **
V. Lead Monitoring	Off **	No Change	Off **
V. Upper Limit	2000 Ω	No Change	2000 Ω
Refractories & Blanking			
A. Refractory (PVARP)	275 ms	-	275 ms
A. Absolute Refractory Period[55]	-	No Change	60 ms
V. Refractory	250 ms	325 ms	250 ms
Rate Responsive PVARP/VREF	Low	Off	Low
Shortest PVARP/VREP	170 ms	-	170 ms
Post Ventricular Atrial Blanking (PVAB)	150 ms	-	150 ms
V. Blanking	12 ms	-	12 ms
V. Safety Standby	On	-	On
PVC Options	A Pace on PVC[56]	-	A Pace on PVC[57]
PMT Options	Auto Detect	-	Auto Detect
PMT Detection Rate	110 min^{-1}	-	110 min^{-1}
AT/AF Detection & Response			
Auto Mode Switch	DDIR	-	DDIR
Atrial Tachycardia Detection Rate	180 min^{-1}		180 min^{-1}
AMS Base Rate	80 min^{-1}	-	80 min^{-1}
AF Suppression™	Off	-	Off
Overdrive Pacing Cycles	-	-	15 cycles
Maximum AF Suppression Rate	-	-	120 min^{-1}

* Not programmable in Model PM2134

** Once the device detects the presence of a lead, the setting automatically switches from Off to Monitor.

Programmable Parameters, Settings, and Tolerances

Table 22. Programmable parameters, settings, and tolerances for Sustain Dual-Chamber Devices (Models PM2134, PM2136)

Parameter	Settings	Units	Tolerance
Basic Operation			
Mode	AOO(R); AAI (R); AAT(R); OAO; VOO(R); VVI(R); VVT(R); VDD(R); OVO; DOO(R); DVI(R); DDI(R); DDD(R); ODO	n/a	n/a

[53] If Lead Type is programmed to "Bipolar Only," the Emergency VVI setting will be Bipolar.
[54] If Lead Type is programmed to "Bipolar Only," the Emergency VVI setting will be Bipolar.
[55] Only available in AAI(R) and AAT(R) modes.
[56] In VDD mode, the setting is +PVARP on PVC.
[57] In VDD mode, the setting is +PVARP on PVC.

Table 22. Programmable parameters, settings, and tolerances for Sustain Dual-Chamber Devices (Models PM2134, PM2136)

Parameter	Settings	Units	Tolerance
Magnet Response	Off; Battery Test	n/a	n/a
Sensor *	On; Off; Passive	n/a	n/a
Max Sensor Rate *	80 – 150 in steps of 5; 160 – 180 in steps of 10	min^{-1}	± 16ms
Threshold *	1 – 7 in steps of 0.5; Auto (-0.5); Auto (+0.0); Auto (+0.5); Auto (+1.0); Auto (+1.5); Auto (+2.0)	n/a	n/a
Slope *	1 – 16; Auto (-1); Auto (+0); Auto (+1); Auto (+2); Auto (+3)	n/a	n/a
Reaction Time *	Very Fast; Fast; Medium; Slow	n/a	n/a
Recovery Time *	Fast; Medium; Slow; Very Slow	n/a	n/a
Rates			
Base Rate	30[58]; 40 – 130 in steps of 5; 140 – 170 in steps of 10	min^{-1}	+ 30/- 8 ms
Rest Rate *	Off; 30 – 130 in steps of 5; 140; 150	min^{-1}	± 16 ms
Max Tracking Rate	90 – 130 in steps of 5; 140 – 180 in steps of 10	min^{-1}	± 16 ms
Hysteresis Rate[59]	Off; 30 – 130 in steps of 5; 140; 150	min^{-1}	+ 25/- 8 ms
Search Interval	Off; 5; 10; 15; 30	min	± 4 sec
Cycle Count	1-16	cycles	n/a
Intervention Rate	Off; Base Rate; Intrinsic+0; Intrinsic+10; Intrinsic+20; Intrinsic+30; 80 – 120 in steps of 10[60]	min^{-1}	± 16 ms[61]
Intervention Duration	1-10	min	± 4 sec
Recovery Time	Fast; Medium; Slow; Very Slow	n/a	n/a
Delays			
Paced AV Delay	25; 30 – 200 in steps of 10; 225 – 300 in steps of 25; 350	ms	± 16
Sensed AV Delay	25; 30 – 200 in steps of 10; 225 – 325 in steps of 25	ms	+ 25/- 8
Rate Responsive AV Delay	Off; Low (1); Medium (2); High (3)	ms/min^{-1}	± 16 ms
Shortest AV Delay	30 – 50 in steps of 5; 60 – 120 in steps of 10	ms	± 16
Ventricular Intrinsic Preference (VIP™)	Off; 50; 75; 100; 125; 150; 160; 170; 180; 190; 200	ms	± 8
VIP Search Interval	30 sec; 1, 3, 5, 10, 30 min	sec; min	± 4 sec
VIP Search Cycles	1; 2;3	n/a	cycles
Negative AV Hysteresis w/Search	Off; -10 to -110 in steps of 10	ms	± 8
Capture & Sense			
V. AutoCapture™	On; Off	n/a	n/a
A. Pulse Amplitude	0.0 – 4.0 in steps of 0.25; 4.5 – 7.5 in steps of 0.5	V	± 30%[62]
V. Pulse Amplitude	0.0 – 4.0 in steps of 0.25; 4.5 – 7.5 in steps of 0.5	V	± 30%[63]
A. Pulse Width	0.05; 0.1 – 1.5 in steps of 0.1	ms	± 0.04
V. Pulse Width	0.05; 0.1 - 1.5 in steps of 0.1	ms	± 0.04

[58] The actual pacing rate for the 30 min-1 setting is 31 min-1.
[59] The highest available setting for the Hysteresis Rate parameter will be 5 min-1 below the programmed Base Rate parameter.
[60] If the Base Rate parameter is programmed lower than 60 min-1, the lowest available Intervention Rate setting is 60 min-1.
[61] Tolerance is for fixed values. For intrinsic values, the tolerance is ± 5 min-1.
[62] Tolerances are measured against impedances 500 W and above. For the 0.0 V setting, the tolerance is 0 – 75 mV.
[63] Tolerances are measured against impedances 500 W and above. For the 0.0 V setting, the tolerance is 0 – 75 mV.

Table 22. Programmable parameters, settings, and tolerances for Sustain Dual-Chamber Devices (Models PM2134, PM2136)

Parameter	Settings	Units	Tolerance
A. Amplitude Monitoring	On; Off	n/a	n/a
V. Amplitude Monitoring	On; Off	n/a	n/a
A. Sensitivity[64]	0.1 **; 0.2 **; 0.3 **; 0.4 **; 0.5; 0.75; 1.0; 1.25; 1.5; 1.75; 2.0; 2.5; 3.0; 3.5; 4.0; 5.0	mV	± 30%[65]
V. Sensitivity[66]	0.5 – 5.0 in steps of 0.5; 6 – 10 in steps of 1.0; 12.5	mV	± 30%[67]
Backup Pulse Configuration	Unipolar; Bipolar	n/a	n/a
Search Frequency	8; 24	hrs	± 30 sec
Leads			
A. Lead Type	Uncoded; Unipolar; Bipolar Only; Uni/Bi	n/a	n/a
V. Lead Type	Uncoded; Unipolar; Bipolar Only; Uni/Bi	n/a	n/a
A. Pulse Configuration	Unipolar (tip-case); Bipolar (tip-ring)	n/a	n/a
V. Pulse Configuration	Unipolar (tip-case); Bipolar (tip-ring)	n/a	n/a
A. Sense Configuration	Unipolar Tip (tip-case); Bipolar (tip-ring); Unipolar Ring (ring-case)	n/a	n/a
V. Sense Configuration	Unipolar Tip (tip-case); Bipolar (tip-ring); Unipolar Ring (ring-case)	n/a	n/a
A. Lead Monitoring	Off; Monitor; Polarity Switch	n/a	n/a
V. Lead Monitoring	Off; Monitor; Polarity Switch	n/a	n/a
V. Upper Limit	750, 1000, 1250, 1500, 1750, 2000	Ω	± 15%
Refractories & Blanking			
A. Refractory (PVARP)	125 – 500 in steps of 25	ms	± 16
A. Absolute Refractory Period[68]	60; 80; 100 – 350 in steps of 25	ms	± 16
V. Refractory[69]	125 – 500 in steps of 25	ms	± 16
Rate Responsive PVARP/VREF	Off; Low (1); Medium (2); High (3)	ms/min^{-1}	± 16 ms
Shortest PVARP/VREF	120 – 350 in steps of 10	ms	± 16
Post Ventricular Atrial Blanking (PVAB)	60; 70; 80; 85; 95; 100; 110; 115; 125; 130; 140; 150; 155; 165; 170; 180; 185; 195; 200	ms	± 16
V. Blanking	12 – 52 in steps of 4	ms	± 8
V. Safety Standby	Off; On	n/a	n/a
PVC Options	Off; A Pace on PVC; +PVARP on PVC[70]	n/a	n/a
PMT Options	Off; 10 Beats > PMT; Auto Detect	n/a	n/a
PMT Detection Rate	90 – 150 in steps of 5; 160 – 180 in steps of 10	min^{-1}	± 16 ms
AT/AF Detection & Response			

[64] Sensitivity is with respect to a 20 ms haversine test signal.
[65] For settings of 0.75 mV and below, tolerance is ± 50%.
[66] Sensitivity is with respect to a 20 ms haversine test signal.
[67] For 0.5 mV setting, tolerance is ± 50%.
[68] Only available in AAI(R) and AAT(R) modes in Models 5386, 5380, and 5286.
[69] In dual-chamber modes, the maximum V. Refractory Period is 325 ms.
[70] Only available in VDD(R) modes.

Table 22. Programmable parameters, settings, and tolerances for Sustain Dual-Chamber Devices (Models PM2134, PM2136)

Parameter	Settings	Units	Tolerance
Auto Mode Switch[71]	Off; DDD to DDI; DDD to DDIR; DDDR to DDI; DDDR to DDIR; VDD to VVI; VDD to VVIR; VDDR to VVI; VDDR to VVIR	n/a	n/a
Atrial Tachycardia Detection Rate	110 – 150 in steps of 5; 160 – 200 in steps of 10; 225 – 300 in steps of 25	min^{-1}	± 16 ms
AMS Base Rate	Base Rate +0 to Base Rate +35 in steps of 5[72]	min^{-1}	± 16 ms
AF Suppression™	On; Off	n/a	n/a
Maximum AF Suppression Rate	80 — 150 in steps of 5; 160; 170; 180	min^{-1}	± 16 ms
Overdrive Pacing Cycles	15 – 40 in steps of 5	cycles	n/a

* Not programmable in Model PM2134.

** Except in VDD(R), settings 0.1 to 0.4 mV are not available when A. Sense Configuration is set to Unipolar.

Sustain™ Single-Chamber Devices (Models PM1134, PM1136)

Shipped, Emergency VVI, and Standard Settings

Table 23. Shipped, Emergency VVI, and Standard settings for Sustain Single-Chamber Devices (Models PM1134, PM1136)

Parameter	Shipped Settings	Emergency VVI Settings	Standard[73] (Nominal) Settings
Basic Operation			
Mode	VVI	VVI	VVI
Magnet Response	Battery Test	Battery Test	Battery Test
Sensor *	Passive	Off	Passive
Max Sensor Rate *	130 min^{-1}	No Change	130 min^{-1}
Threshold *	Auto (+ 0.0)	No Change	Auto (+ 0.0)
Slope *	Auto (+2)	No Change	Auto (+2)
Reaction Time *	Fast	No Change	Fast
Recovery Time *	Medium	No Change	Medium
Rates			
Base Rate	60 min^{-1}	70 min^{-1}	60 min^{-1}
Rest Rate *	Off	Off	Off
Hysteresis Rate	Off	Off	Off
Search Interval	-	-	5 min
Cycle Count	-	-	1
Intervention Rate	-	-	Off
Intervention Duration	-	-	3 min
Recovery Time	-	-	Medium
Capture & Sense			
V. AutoCapture™	Off	Off	Off
Pulse Amplitude	2.5 V	7.5 V	2.5 V
Pulse Width	0.4 ms	0.6 ms	0.4 ms
Amplitude Monitoring	On	No Change	On
Sensitivity	2.0 mV	2.0 mV	2.0 mV
Backup Pulse Configuration	-	-	Bipolar
Search Frequency	-	-	8 hrs

[71] Rate-responsive settings (for example, DDI to DDIR) are not available in the Model PM2134.
[72] These represent formulas for computing AMS Base Rate settings. Actual settings appear as numerical rates.
[73] If parameters have not been previously programmed and are not autoprogrammed, the device will institute these standard or nominal settings.

Table 23. Shipped, Emergency VVI, and Standard settings for Sustain Single-Chamber Devices (Models PM1134, PM1136)

Parameter	Shipped Settings	Emergency VVI Settings	Standard[73] (Nominal) Settings
Leads			
Lead Type	Uncoded	No Change	Uncoded
Pulse Configuration	See Package Label	Unipolar[74]	See Package Label
Sense Configuration	See Package Label	Unipolar Tip[75]	See Package Label
Lead Monitoring	Off[76]	No Change	Off[77]
Upper Limit	2000 Ω	No Change	2000 Ω
Refractories & Blanking			
Refractory	325 ms	325 ms	325 ms
Rate Responsive VREF	Off	Off	Low
Shortest VREF	170 ms	-	170 ms

* Not programmable in Model PM1134

Programmable Parameters, Settings, and Tolerances

Table 24. Programmable parameters, settings, and tolerances for Sustain Single-Chamber Devices (Models PM1134, PM1136)

Parameter	Settings	Units	Tolerance
Basic Operation			
Mode	AOO(R); AAI (R); AAT(R); OAO; VOO(R); VVI(R); VVT(R); OVO	n/a	n/a
Magnet Response	Off; Battery Test	n/a	n/a
Sensor *	On; Off; Passive	n/a	n/a
Max Sensor Rate *	80 – 150 in steps of 5; 160 – 180 in steps of 10	min^{-1}	± 16ms
Threshold *	1 – 7 in steps of 0.5; Auto (-0.5); Auto (+0.0); Auto (+0.5); Auto (+1.0); Auto (+1.5); Auto (+2.0)	n/a	n/a
Slope *	1 – 16; Auto (-1); Auto (+0); Auto (+1); Auto (+2); Auto (+3)	n/a	n/a
Reaction Time *	Very Fast; Fast; Medium; Slow	n/a	n/a
Recovery Time *	Fast; Medium; Slow; Very Slow	n/a	n/a
Rates			
Base Rate	30[78]; 40 – 130 in steps of 5; 140 – 170 in steps of 10	min^{-1}	+ 30/- 8 ms
Rest Rate *	Off; 30 – 130 in steps of 5; 140; 150	min^{-1}	± 16 ms
Hysteresis Rate[79]	Off; 30 – 130 in steps of 5; 140; 150	min^{-1}	+ 25/- 8 ms
Search Interval	Off; 5; 10; 15; 30	min	± 4 sec
Cycle Count	1-16	cycles	n/a
Intervention Rate	Off; Base Rate; Intrinsic+0; Intrinsic+10; Intrinsic+20; Intrinsic+30; 80 – 120 in steps of 10[80]	min^{-1}	± 16 ms[81]
Intervention Duration	1-10	min	± 4 sec

[74] If Lead Type is programmed to "Bipolar Only," the Emergency VVI setting will be Bipolar.
[75] If Lead Type is programmed to "Bipolar Only," the Emergency VVI setting will be Bipolar.
[76] Once the device detects the presence of a lead, the setting automatically switches from Off to Monitor.
[77] Once the device detects the presence of a lead, the setting automatically switches from Off to Monitor.
[78] The actual pacing rate for the 30 min-1 setting is 31 min-1.
[79] The highest available setting for the Hysteresis Rate parameter will be 5 min-1 below the programmed Base Rate parameter.
[80] If the Base Rate parameter is programmed lower than 60 min-1, the lowest available Intervention Rate setting is 60 min-1.
[81] Tolerance is for fixed values. For intrinsic values, the tolerance is ± 5 min-1.

Table 24. Programmable parameters, settings, and tolerances for Sustain Single-Chamber Devices (Models PM1134, PM1136)

Parameter	Settings	Units	Tolerance
Recovery Time	Fast; Medium; Slow; Very Slow	n/a	n/a
Capture & Sense			
V. AutoCapture™	On; Off	n/a	n/a
Pulse Amplitude	0.0 – 4.0 in steps of 0.25; 4.5 – 7.5 in steps of 0.5	V	± 30%[82]
Pulse Width	0.05; 0.1 – 1.5 in steps of 0.1	ms	± 0.04
Amplitude Monitoring	On; Off	n/a	n/a
Sensitivity[83]	0.5 – 5.0 in steps of 0.5; 6 – 10 in steps of 1.0; 12.5	mV	± 30%[84]
Backup Pulse Configuration	Unipolar; Bipolar	n/a	n/a
Search Frequency	8; 24	hrs	± 30 sec
Leads			
Lead Type	Uncoded; Unipolar; Bipolar Only; Uni/Bi	n/a	n/a
Pulse Configuration	Unipolar (tip-case); Bipolar (tip-ring)	n/a	n/a
Sense Configuration	Unipolar Tip (tip-case); Bipolar (tip-ring); Unipolar Ring (ring-case)	n/a	n/a
Lead Monitoring	Off; Monitor; Polarity Switch	n/a	n/a
Upper Limit	750, 1000, 1250, 1500, 1750, 2000	Ω	±15%
Refractories & Blanking			
Refractory	125 – 500 in steps of 25	ms	± 16
Rate Responsive AREF/VREF	Off; Low (1); Medium (2); High (3)	ms/min^{-1}	± 16 ms
Shortest AREF/VREF	120 – 350 in steps of 10	ms	± 16

* Not programmable in Model PM1134.

Episode Configuration and Trigger Settings

Table 25. Episode Configuration and Trigger settings for Sustain devices

Parameter	Settings[85]	Units	Tolerance
Configuration			
Sampling Options	**Freeze;** Continuous	n/a	n/a
No. of Stored Episodes	1; 2; **4;** 8; 12	n/a	n/a
Channel	Single; **Dual**[86]	n/a	n/a
EGM Configuration[87]	**V Bipolar**; V Unipolar Tip; V Unipolar Ring; Atip-Vtip; Aring-Vring; A Bipolar; A Unipolar Tip; A Unipolar Ring	n/a	n/a
EGM Recording Range	± 15.0; ± 7.5; ± 3.0; ± 1.5	mV	± 20%
A. EGM Configuration[88]	**A Bipolar**; A Unipolar Tip; A Unipolar Ring; Atip-Vtip; Aring-Vtip	n/a	n/a
A. EGM Recording Range	± 15.0; ± 7.5; **± 3.0**; ± 1.5	mV	± 20%
V. EGM Configuration **	**V Bipolar**; V Unipolar Tip; V Unipolar Ring; Atip-Vtip; Aring-Vtip; Aring-Vring	n/a	n/a

[82] Tolerances are measured against impedances 500 W and above. For the 0.0 V setting, the tolerance is 0 – 75 mV.
[83] Sensitivity is with respect to a 20 ms haversine test signal.
[84] For 0.5 mV setting, tolerance is ± 50%.
[85] Standard settings are in bold face.
[86] The standard setting for single-chamber modes is Single.
[87] These settings are available when the Channel parameter is set to Single and when both Lead Type parameters are set to either Uni/Bi or Bipolar. For more information, see EGM Configuration.
[88] These settings are available when the A. Lead Type parameter is set to Uni/Bi or Bipolar Only and the Channel parameter is set to Dual. If the A. Lead Type is Unipolar, then the standard setting is A Unipolar Tip. For more information, see EGM Configuration.

Table 25. Episode Configuration and Trigger settings for Sustain devices

Parameter	Settings[85]	Units	Tolerance
Configuration			
V. EGM Recording Range	**± 15.0**; ± 7.5; ± 3.0; ± 1.5	mV	± 20%
Episode Triggers			
Atrial Trigger	AT/AF; High Atrial Rate; AMS *; **Off**	n/a	n/a
Trigger Type	Entry & Exit; Exit; **Entry**	n/a	n/a
High A. Rate Trigger	**Off**; 125 – 300 in steps of 25	**min^{-1}**	± 16 ms
Consecutive Cycles	2; 3; 4; **5**; 10; 15; 20	n/a	n/a
High V. Rate Trigger	**Off**; 125 – 300 in steps of 25	**min^{-1}**	± 16 ms
Consecutive Cycles	2; 3; 4; **5**; 10; 15; 20	n/a	n/a
PVC Trigger *	On; **Off**	n/a	n/a
Consecutive PVCs *	**2**; 3; 4; 5	n/a	n/a
Advanced Hysteresis Trigger	On; **Off**	n/a	n/a
PMT Detection Trigger *	On; **Off**		
Magnet Placement Trigger	On; **Off**	n/a	n/a

* Not available in single chamber modes.

** These settings are available when the V. Lead Type parameter is set to Uni/Bi or Bipolar Only and the Channel parameter is set to Dual. If the V. Lead Type is Unipolar, then the standard setting is V Unipolar Tip. If the V. Lead Type parameter is set to Single-Pass VDD, the options are: Vring-Adist; Vring-Aprox; Vtip-Adist; Vtip-Aprox; V Unipolar Ring; V Bipolar; V Unipolar Tip; Aprox-Vtip; Aprox-Case; Aprox-Vring; Adist-Aprox; Adist-Vtip; Adist-Case; Adist-Vring. (Atrial Standard is Adist-Vring; Ventricular Standard is V Bipolar.) For more information, see EGM Configuration.

NIPS Options

Table 26. NIPS options for Sustain devices

Parameter	Settings[89]	Units	Tolerance
Stimulation Chamber	**Atrial**[90]; Ventricular	n/a	n/a
Coupling Interval[91]	100 – 800 in steps of 10 **(500)**	ms	± 8
S1 Count	1 – 25 in steps of 1 **(8)**	n/a	n/a
S1[92], S2, S3, and S4 Cycle	Off; 100 – 800 in steps of 10 **(500)**[93]	ms	± 6
V. Backup Rate (VOO Pacing)[94]	Off; 30; 40 – 95 in steps of 5 **(50)**	**min^{-1}**	± 30 ms
Sinus Node Recovery Delay	**1** – 5 in steps of 1	sec	± 100 ms

Physical Specifications

Table 27. Physical specifications for Sustain devices

	PM2134 **PM2136**	**PM1134** **PM1136**
Case Material	Titanium	Titanium
Case Coating	Uncoated	Uncoated
Connector Material	Composite Polymer	Composite Polymer
Dimensions [95](mm)	44(h) x 52(l) x 6(t)	42(h) x 52(l) x 6(t)
Weight [96](g)	23.5	23
Volume[97] (cm³)	11	10.4

[89] Standard settings are in bold face.
[90] Atrial setting is not available in VDD(R) mode.
[91] During atrial NIPS in dual-chamber modes, the shortest Coupling Interval will be limited by the programmed Paced/Sensed AV Delay.
[92] S1 Burst Cycle is applied at the preprogrammed S1 cycle length.
[93] The standard setting for S2, S3, and S4 is Off.
[94] Not available in single-chamber modes.
[95] These values are nominal.
[96] These values are nominal.
[97] ± 0.5 cm³.

Table 27. Physical specifications for Sustain devices

	PM2134 PM2136	PM1134 PM1136
Power Source	1 lithium iodine cell	1 lithium iodine cell
Manufacturer	Greatbatch Medical, Model WG 9438	Greatbatch Medical, Model WG 9438
Lead Connector	IS-1 compatible[98]	IS-1 compatible[99]
X-ray ID Code	VW	VW

[98] Accepts all IS-1, VS•1, and 3.2 mm leads.
[99] Accepts all IS-1, VS•1, and 3.2 mm leads.

Appendix B. Victory™ Devices Technical Data

The technical data below include:

Victory™ Dual-Chamber Devices (Models 5816, 5810)

Shipped, Emergency VVI, and Standard Settings

Table 28. Shipped, Emergency VVI, and Standard settings for Victory dual-chamber devices (Models 5816, 5810)

Parameter	Shipped Settings	Emergency VII Settings	Standard (Nominal) Settings[100]
Basic Operation			
Mode	DDD	VVI	DDD
Magnet Response	Battery Test	Battery Test	Battery Test
Sensor	Passive	Off	Passive
Max Sensor Rate	130 min^{-1}	No Change	130 min^{-1}
Threshold	Auto (+ 0.0)	No Change	Auto (+ 0.0)
Slope	Auto (+2)	No Change	Auto (+2)
Reaction Time	Fast	No Change	Fast
Recovery Time	Medium	No Change	Medium
Rates			
Base Rate	60 min^{-1}	70 min^{-1}	60 min^{-1}
Rest Rate	Off	Off	Off
Max Tracking Rate	130 min^{-1}	-	130 min^{-1}
Hysteresis Rate	Off	Off	Off
Search Interval	-	-	Off
Cycle Count	-	-	1
Intervention Rate	-	-	Off
Intervention Duration	-	-	3 min
Recovery Time	-	-	Medium
Delays			
Paced AV Delay	200 ms	-	200 ms
Sensed AV Delay	150 ms	-	150 ms
Rate Responsive AV Delay	Off	-	Off
Shortest AV Delay	100 ms	-	100 ms
Ventricular Intrinsic Preference (VIP™)	Off	-	Off
VIP Search Interval	-	-	1 min
VIP Search Cycles	-	-	1 cycle
Negative AV/PV Hysteresis w/Search	Off	-	Off
Capture & Sense			
V. AutoCapture™	Off	Off	Off
A, Pulse Amplitude	2.5 V	-	2.5 V
V. Pulse Amplitude	2.5 V	7.5 V	2.5 V
A. Pulse Width	0.4 ms	-	0.4 ms

[100] If parameters have not been previously programmed and are not autoprogrammed, the device will institute these standard or nominal settings.

Table 28. Shipped, Emergency VVI, and Standard settings for Victory dual-chamber devices (Models 5816, 5810)

Parameter	Shipped Settings	Emergency VII Settings	Standard (Nominal) Settings[100]
V. Pulse Width	0.4 ms	0.6 ms	0.4 ms
A. Amplitude Monitoring	On	No Change	On
V. Amplitude Monitoring	On	No Change	On
A. Sensitivity	0.5 mV	-	0.5 mV
V. Sensitivity	2.0 mV	2.0 mV	2.0 mV
Backup Pulse Configuration	-	-	Bipolar
Search Frequency	-	-	8 hrs
Leads			
A. Lead Type	Uncoded	No Change	Uncoded
V. Lead Type	Uncoded	No Change	Uncoded
A. Pulse Configuration	See Package Label	-	See Package Label
V. Pulse Configuration	See Package Label	Unipolar[101]	See Package Label
A. Sense Configuration	See Package Label	-	See Package Label
V. Sense Configuration	See Package Label	Unipolar Tip[102]	See Package Label
A. Lead Monitoring	Off *	-	Off *
V. Lead Monitoring	Off *	No Change	Off *
V. Upper Limit	2000 Ω	No Change	2000 Ω
Refractories & Blanking			
A. Refractory (PVARP)	275 ms	-	275 ms
A. Absolute Refractory Period[103]	-	No Change	60 ms
V. Refractory	250 ms	325 ms	250 ms
Rate Responsive PVARP/VREF	Low	Off	Low
Shortest PVARP/VREF	170 ms	-	170 ms
Post Ventricular Atrial Blanking (PVAB)	150 ms	-	150 ms
V. Blanking	12 ms	-	12 ms
V. Safety Standby	On	-	On
PVC Options	A Pace on PVC[104]	-	A Pace on PVC[105]
PMT Options	Auto Detect	-	Auto Detect
PMT Detection Rate	110 min^{-1}	-	110 min^{-1}
AT/AF Detection & Response			
Auto Mode Switch	DDIR	-	DDIR
Atrial Tachycardia Detection Rate	180 min^{-1}		180 min^{-1}
AMS Base Rate	80 min^{-1}	-	80 min^{-1}
AF Suppression™	Off	-	Off
Overdrive Pacing Cycles	-	-	15 cycles
Maximum AF Suppression Rate	-	-	120 min^{-1}

* Once the device detects the presence of a lead, the setting automatically switches from Off to Monitor.

[101] If the Lead Type parameter is programmed to "Bipolar Only," the Emergency VVI setting will be Bipolar.
[102] If the Lead Type parameter is programmed to "Bipolar Only," the Emergency VVI setting will be Bipolar.
[103] Only available in AAI(R) and AAT(R) modes.
[104] In VDD mode, the setting is +PVARP on PVC.
[105] In VDD mode, the setting is +PVARP on PVC.

Programmable Parameters, Settings, and Tolerances

Table 29. Programmable parameters, settings, and tolerances for Victory dual-chamber devices (Models 5816, 5810)

Parameter	Settings	Units	Tolerance
Basic Operation			
Mode	AOO(R); AAI (R); AAT(R); OAO; VOO(R); VVI(R); VVT(R); VDD(R); OVO; DOO(R); DVI(R); DDI(R); DDD(R); ODO	n/a	n/a
Magnet Response	Off; Battery Test	n/a	n/a
Sensor	On; Off; Passive	n/a	n/a
Max Sensor Rate	80 – 150 in steps of 5; 160 – 180 in steps of 10	min^{-1}	± 16ms
Threshold	1 – 7 in steps of 0.5; Auto (-0.5); Auto (+0.0); Auto (+0.5); Auto (+1.0); Auto (+1.5); Auto (+2.0)	n/a	n/a
Slope	1 – 16; Auto (-1); Auto (+0); Auto (+1); Auto (+2); Auto (+3)	n/a	n/a
Reaction Time	Very Fast; Fast; Medium; Slow	n/a	n/a
Recovery Time	Fast; Medium; Slow; Very Slow	n/a	n/a
Rates			
Base Rate	30[106]; 40 – 130 in steps of 5; 140 – 170 in steps of 10	min^{-1}	+ 30/- 8 ms
Rest Rate	Off; 30 – 130 in steps of 5; 140; 150	min^{-1}	± 16 ms
Max Tracking Rate	90 – 130 in steps of 5; 140 – 180 in steps of 10	min^{-1}	± 16 ms
Hysteresis Rate[107]	Off; 30 – 130 in steps of 5; 140; 150	min^{-1}	+ 25/- 8 ms
Search Interval	Off; 5; 10; 15; 30	min	± 4 sec
Cycle Count	1-16	cycles	n/a
Intervention Rate	Off; Base Rate; Intrinsic+0; Intrinsic+10; Intrinsic+20; Intrinsic+30; 80 – 120 in steps of 10[108]	min^{-1}	± 16 ms[109]
Intervention Duration	1 – 10	min	± 4 sec
Recovery Time	Fast; Medium; Slow; Very Slow	n/a	n/a
Delays			
Paced AV Delay	25; 30 – 200 in steps of 10; 225 – 300 in steps of 25; 350	ms	± 16
Sensed AV Delay	25; 30 – 200 in steps of 10; 225 – 325 in steps of 25	ms	+ 25/- 8
Rate Responsive AV Delay	Off; Low (1); Medium (2); High (3)	ms/min^{-1}	± 16 ms
Shortest AV Delay	30 – 50 in steps of 5; 60 – 120 in steps of 10	ms	± 16
Ventricular Intrinsic Preference (VIP™)	Off; 50; 75; 100; 125; 150; 160; 170; 180; 190; 200	ms	± 8
VIP Search Interval	30 sec; 1, 3, 5, 10, 30 min	sec; min	± 4 sec
VIP Search Cycles	1; 2; 3	n/a	cycles
Negative AV Hysteresis w/Search	Off; -10 to -110 in steps of 10	ms	± 8
Capture & Sense			
V. AutoCapture™	On; Off	n/a	n/a

[106] The actual pacing rate for the 30 min-1 setting is 31 min-1.
[107] The highest available setting for the Hysteresis Rate parameter will be 5 min-1 below the programmed Base Rate parameter.
[108] If the Base Rate parameter is programmed lower than 60 min-1, the lowest available Intervention Rate setting is 60 min-1.
[109] Tolerance is for fixed values. For intrinsic values, the tolerance is ± 5 min-1.

Table 29. Programmable parameters, settings, and tolerances for Victory dual-chamber devices (Models 5816, 5810)

Parameter	Settings	Units	Tolerance
A. Pulse Amplitude	0.0 – 4.0 in steps of 0.25; 4.5 – 7.5 in steps of 0.5	V	± 30%[110]
V. Pulse Amplitude	0.0 – 4.0 in steps of 0.25; 4.5 – 7.5 in steps of 0.5	V	± 30%[111]
A. Pulse Width	0.05; 0.1 – 1.5 in steps of 0.1	ms	± 0.04
V. Pulse Width	0.05; 0.1 - 1.5 in steps of 0.1	ms	± 0.04
A. Amplitude Monitoring	On; Off	n/a	n/a
V. Amplitude Monitoring	On; Off	n/a	n/a
A. Sensitivity[112]	0.1 *; 0.2 *; 0.3 *; 0.4 *; 0.5; 0.75; 1.0; 1.25; 1.5; 1.75; 2.0; 2.5; 3.0; 3.5; 4.0; 5.0	mV	± 30%[113]
V. Sensitivity[114]	0.5 – 5.0 in steps of 0.5; 6 – 10 in steps of 1.0; 12.5	mV	± 30%[115]
Backup Pulse Configuration	Unipolar; Bipolar	n/a	n/a
Search Frequency	8; 24	hrs	± 30 sec
Leads			
A. Lead Type	Uncoded; Unipolar; Bipolar Only; Uni/Bi	n/a	n/a
V. Lead Type	Uncoded; Unipolar; Bipolar Only; Uni/Bi	n/a	n/a
A. Pulse Configuration	Unipolar (tip-case); Bipolar (tip-ring)	n/a	n/a
V. Pulse Configuration	Unipolar (tip-case); Bipolar (tip-ring)	n/a	n/a
A. Sense Configuration	Unipolar Tip (tip-case); Bipolar (tip-ring); Unipolar Ring (ring-case)	n/a	n/a
V. Sense Configuration	Unipolar Tip (tip-case); Bipolar (tip-ring); Unipolar Ring (ring-case)	n/a	n/a
A. Lead Monitoring	Off; Monitor; Polarity Switch	n/a	n/a
V. Lead Monitoring	Off; Monitor; Polarity Switch	n/a	n/a
V. Upper Limit	750, 1000, 1250, 1500, 1750, 2000	Ω	±15%
Refractories & Blanking			
A. Refractory (PVARP)	125 – 500 in steps of 25	ms	± 16
A. Absolute Refractory Period[116]	60; 80; 100 – 350 in steps of 25	ms	± 16
V. Refractory[117]	125 – 500 in steps of 25	ms	± 16
Rate Responsive PVARP/VREF	Off; Low (1); Medium (2); High (3)	ms/min^{-1}	± 16 ms
Shortest PVARP/VREF	120 – 350 in steps of 10	ms	± 16
Post Ventricular Atrial Blanking (PVAB)	60; 70; 80; 85; 95; 100; 110; 115; 125; 130; 140; 150; 155; 165; 170; 180; 185; 195; 200	ms	± 16
V. Blanking	12 – 52 in steps of 4	ms	± 8
V. Safety Standby	Off; On	n/a	n/a
PVC Options	Off; A Pace on PVC; +PVARP on PVC[118]	n/a	n/a

[110] Tolerances are measured against impedances 500 W and above. For the 0.0 V setting, the tolerance is 0 – 75 mV.
[111] Tolerances are measured against impedances 500 W and above. For the 0.0 V setting, the tolerance is 0 – 75 mV.
[112] Sensitivity is with respect to a 20 ms haversine test signal.
[113] For settings of 0.75 mV and below, tolerance is ± 50%.
[114] Sensitivity is with respect to a 20 ms haversine test signal.
[115] For 0.5 mV setting, tolerance is ± 50%.
[116] Only available in AAI(R) and AAT(R) modes.
[117] In dual-chamber modes, the maximum V. Refractory Period is 325 ms.
[118] Only available in VDD(R) modes.

Table 29. Programmable parameters, settings, and tolerances for Victory dual-chamber devices (Models 5816, 5810)

Parameter	Settings	Units	Tolerance
PMT Options	Off; 10 Beats > PMT; Auto Detect	n/a	n/a
PMT Detection Rate	90 – 150 in steps of 5; 160 – 180 in steps of 10	min^{-1}	± 16 ms
AT/AF Detection & Response			
Auto Mode Switch	Off; DDD to DDI; DDD to DDIR; DDDR to DDI; DDDR to DDIR; VDD to VVI; VDD to VVIR; VDDR to VVI; VDDR to VVIR	n/a	n/a
Atrial Tachycardia Detection Rate	110 – 150 in steps of 5; 160 – 200 in steps of 10; 225 – 300 in steps of 25	min^{-1}	± 16 ms
AMS Base Rate	Base Rate +0 to Base Rate +35 in steps of 5[119]	min^{-1}	± 16 ms
AF Suppression™	On; Off	n/a	n/a
Maximum AF Suppression Rate	80 — 150 in steps of 5; 160; 170; 180	min^{-1}	±16 ms
Overdrive Pacing Cycles	15 – 40 in steps of 5	cycles	n/a

* Except in VDD(R), settings 0.1 to 0.4 mV are not available when A. Sense Configuration is set to Unipolar.

Victory™ Single-Chamber Devices (Model 5610)

Shipped, Emergency VVI, and Standard Settings

Table 30. Shipped, Emergency VVI, and Standard settings for Victory single-chamber devices (Model 5610)

Parameter	Shipped Settings	Emergency VII Settings	Standard (Nominal) Settings[120]
Basic Operation			
Mode	VVI	VVI	VVI
Magnet Response	Battery Test	Battery Test	Battery Test
Sensor	Passive	Off	Passive
Max Sensor Rate	130 min^{-1}	No Change	130 min^{-1}
Threshold	Auto (+ 0.0)	No Change	Auto (+ 0.0)
Slope	Auto (+2)	No Change	Auto (+2)
Reaction Time	Fast	No Change	Fast
Recovery Time	Medium	No Change	Medium
Rates			
Base Rate	60 min^{-1}	70 min^{-1}	60 min^{-1}
Rest Rate	Off	Off	Off
Hysteresis Rate	Off	Off	Off
Search Interval	-	-	5 min
Cycle Count	-	-	1
Intervention Rate	-	-	Off
Intervention Duration	-	-	3 min
Recovery Time	-	-	Medium
Capture & Sense			
V. AutoCapture™	Off	Off	Off
Pulse Amplitude	2.5 V	7.5 V	2.5 V
Pulse Width	0.4 ms	0.6 ms	0.4 ms
Amplitude Monitoring	On	No Change	On
Sensitivity	2.0 mV	2.0 mV	2.0 mV

[119] These represent formulas for computing AMS Base Rate settings. Actual settings appear as numerical rates.
[120] If parameters have not been previously programmed and are not autoprogrammed, the device will institute these standard or nominal settings.

Table 30. Shipped, Emergency VVI, and Standard settings for Victory single-chamber devices (Model 5610)

Parameter	Shipped Settings	Emergency VII Settings	Standard (Nominal) Settings[120]
Backup Pulse Configuration	-	-	Bipolar
Search Frequency	-	-	8 hrs
Leads			
Lead Type	Uncoded	No Change	Uncoded
Pulse Configuration	See Package Label	Unipolar[121]	See Package Label
Sense Configuration	See Package Label	Unipolar Tip[122]	See Package Label
Lead Monitoring	Off[123]	No Change	Off[124]
Upper Limit	2000 Ω	No Change	2000 Ω
Refractories & Blanking			
Refractory	325 ms	325 ms	325 ms
Rate Responsive VREF	Low	Off	Low
Shortest VREF	-	-	200 ms

Programmable Parameters, Settings, and Tolerances

Table 31. Programmable parameters, settings, and tolerances for Victory single-chamber devices (Model 5610)

Parameter	Settings	Units	Tolerance
Basic Operation			
Mode	AOO(R); AAI(R); AAT(R); OAO; VOO(R); VVI(R); VVT(R); OVO	n/a	n/a
Magnet Response	Off; Battery Test	n/a	n/a
Sensor	On; Off; Passive	n/a	n/a
Max Sensor Rate	80 – 150 in steps of 5; 160 – 180 in steps of 10	min^{-1}	± 16ms
Threshold	1 – 7 in steps of 0.5; Auto (-0.5); Auto (+0.0); Auto (+0.5); Auto (+1.0); Auto (+1.5); Auto (+2.0)	n/a	n/a
Slope	1 – 16; Auto (-1); Auto (+0); Auto (+1); Auto (+2); Auto (+3)	n/a	n/a
Reaction Time	Very Fast; Fast; Medium; Slow	n/a	n/a
Recovery Time	Fast; Medium; Slow; Very Slow	n/a	n/a
Rates			
Base Rate	30[125]; 40 – 130 in steps of 5; 140 – 170 in steps of 10	min^{-1}	+ 30/- 8 ms
Rest Rate	Off; 30 – 130 in steps of 5; 140; 150	min^{-1}	± 16 ms
Hysteresis Rate[126]	Off; 30 – 130 in steps of 5; 140; 150	min^{-1}	+ 25/- 8 ms
Search Interval	Off; 5; 10; 15; 30	min	± 4 sec
Cycle Count	1 – 16	cycles	n/a
Intervention Rate	Off; Base Rate; Intrinsic+0; Intrinsic+10; Intrinsic+20; Intrinsic+30; 80 – 120 in steps of 10[127]	min^{-1}	± 16 ms[128]
Intervention Duration	1 – 10	min	± 4 sec
Recovery Time	Fast; Medium; Slow; Very Slow	n/a	n/a

[121] If Lead Type is programmed to "Bipolar Only," the Emergency VVI setting will be Bipolar.
[122] If Lead Type is programmed to "Bipolar Only," the Emergency VVI setting will be Bipolar.
[123] Once the device detects the presence of a lead, the setting automatically switches from Off to Monitor.
[124] Once the device detects the presence of a lead, the setting automatically switches from Off to Monitor.
[125] The actual pacing rate for the 30 min-1 setting is 31 min-1.
[126] The highest available setting for the Hysteresis Rate parameter will be 5 min-1 below the programmed Base Rate parameter.
[127] If the Base Rate parameter is programmed lower than 60 min-1, the lowest available Intervention Rate setting is 60 min-1.
[128] Tolerance is for fixed values. For intrinsic values, the tolerance is ± 5 min-1.

Table 31. Programmable parameters, settings, and tolerances for Victory single-chamber devices (Model 5610)

Parameter	Settings	Units	Tolerance
Capture & Sense			
V. AutoCapture™	On; Off	n/a	n/a
Pulse Amplitude	0.0 – 4.0 in steps of 0.25; 4.5 – 7.5 in steps of 0.5	V	± 30%[129]
Pulse Width	0.05; 0.1 – 1.5 in steps of 0.1	ms	± 0.04
Sensitivity[130]	0.5 – 5.0 in steps of 0.5; 6 – 10 in steps of 1.0; 12.5	mV	± 30%[131]
Amplitude Monitoring	On; Off	n/a	n/a
Backup Pulse Configuration	Unipolar; Bipolar	n/a	n/a
Search Frequency	8, 24	hrs	n/a
Leads			
Lead Type	Uncoded; Unipolar; Bipolar Only; Uni/Bi	n/a	n/a
Pulse Configuration	Unipolar (tip-case); Bipolar (tip-ring)	n/a	n/a
Sense Configuration	Unipolar Tip (tip-case); Bipolar (tip-ring); Unipolar Ring (ring-case)	n/a	n/a
Lead Monitoring	Off; Monitor; Polarity Switch	n/a	n/a
Upper Limit	750; 1000; 1250; 1500; 1750; 2000	Ω	±15%
Refractories & Blanking			
Refractory	125 – 500 in steps of 25	ms	± 16
Rate Responsive AREF/VREF	Off; Low (1); Medium (2); High (3)	ms/**min**$^{-1}$	± 16 ms
Shortest AREF/VREF	120 – 350 in steps of 10	ms	± 16

Episode Configuration and Trigger Settings

Table 32. Episode Configuration and Trigger settings for Victory devices

Parameter	Settings[132]	Units	Tolerance
Configuration			
Sampling Options	**Freeze;** Continuous	n/a	n/a
No. of Stored Episodes	1; 2; **4;** 8; 12	n/a	n/a
Channel	Single; **Dual**[133]	n/a	n/a
EGM Configuration[134]	V Bipolar; V Unipolar Tip; V Unipolar Ring; Atip-Vtip; Aring-Vtip; Aring-Vring; A Bipolar; A Unipolar Tip; A Unipolar Ring	n/a	n/a
EGM Recording Range	± 15.0; ± 7.5; **± 3.0**; ± 1.5	mV	± 20%
A. EGM Configuration[135]	**A Bipolar**; A Unipolar Tip; A Unipolar Ring; Atip-Vtip; Aring-Vtip	n/a	n/a
A. EGM Recording Range	± 15.0; ± 7.5; **± 3.0**; ± 1.5	mV	± 20%
V. EGM Configuration**	**V Bipolar**; V Unipolar Tip; V Unipolar Ring; Atip-Vtip; Aring-Vtip; Aring-Vring	n/a	n/a
V. EGM Recording Range	**± 15.0**; ± 7.5; ± 3.0; ± 1.5	mV	± 20%

[129] Tolerances are measured against impedances 500 W and above. For the 0.0 V setting, the tolerance is 0 – 75 mV.
[130] Sensitivity is with respect to a 20 ms haversine test signal.
[131] For 0.5 mV setting, tolerance is ± 50%.
[132] Standard settings are in bold face.
[133] The standard setting for single-chamber modes is Single.
[134] These settings are available when the Channel parameter is set to Single and when both Lead Type parameters are set to either Uni/Bi or Bipolar. For more information, see EGM Configuration.
[135] These settings are available when the A. Lead Type parameter is set to Uni/Bi or Bipolar Only and the Channel parameter is set to Dual. If the A. Lead Type is Unipolar, then the standard setting is A Unipolar Tip. For more information, see EGM Configuration.

Table 32. Episode Configuration and Trigger settings for Victory devices

Parameter	Settings[132]	Units	Tolerance
Episode Triggers			
Atrial Trigger	AT/AF; High Atrial Rate; AMS *; **Off**	n/a	n/a
Trigger Type	Entry & Exit; Exit; **Entry**	n/a	n/a
High A. Rate Trigger	**Off**; 125 – 300 in steps of 25	min^{-1}	± 16 ms
Consecutive Cycles	2; 3; 4; **5**; 10; 15; 20	n/a	n/a
High V. Rate Trigger	**Off**; 125 – 300 in steps of 25	min^{-1}	± 16 ms
Consecutive Cycles	2; 3; 4; **5**; 10; 15; 20	n/a	n/a
PVC Trigger *	On; **Off**	n/a	n/a
Consecutive PVCs *	**2**; 3; 4; 5	n/a	n/a
Advanced Hysteresis Trigger	On; **Off**	n/a	n/a
PMT Detection Trigger *	On; **Off**	n/a	n/a
Magnet Placement Trigger	On; **Off**	n/a	n/a

* Not available in single chamber mode.

** These settings are available when the V. Lead Type parameter is set to Uni/Bi or Bipolar Only and the Channel parameter is set to Dual. If the V. Lead Type is Unipolar, then the standard setting is V Unipolar Tip. If the V. Lead Type parameter is set to Single-Pass VDD, the options are: Vring-Adist; Vring-Aprox; Vtip-Adist; Vtip-Aprox; V Unipolar Ring; V Bipolar; V Unipolar Tip; Aprox-Vtip; Aprox-Case; Aprox-Vring; Adist-Aprox; Adist-Vtip; Adist-Case; Adist-Vring. (Atrial Standard is Adist-Vring; Ventricular Standard is V Bipolar.) For more information, see EGM Configuration.

NIPS Options

Table 33. NIPS options for Victory devices

Parameter	Settings[136]	Units	Tolerance
Stimulation Chamber	**Atrial**[137]; Ventricular	n/a	n/a
Coupling Interval[138]	100 – 800 in steps of 10 **(500)**	ms	± 8
S1 Count	1 – 25 in steps of 1 **(8)**	n/a	n/a
S1[139], S2, S3, and S4 Cycle	Off; 100 – 800 in steps of 10 **(500)**[140]	ms	± 6
V. Backup Rate (VOO Pacing)[141]	Off; 30; 40 – 95 in steps of 5 **(50)**	min^{-1}	± 30 ms
Sinus Node Recovery Delay	**1** – 5 in steps of 1	sec	± 100 ms

Physical Specifications

Table 34. Physical specifications for Victory devices

	5816	5810	5610
Case Material	Titanium	Titanium	Titanium
Case Coating	Uncoated	Uncoated	Uncoated
Connector Material	Composite Polymer	Composite Polymer	Composite Polymer
Dimensions [142](mm)	44(h) x 52(l) x 6(t)	43(h) x 44(l) x 6(t)	41(h) x 44(l) x 6(t)
Weight [143](g)	23.5	18	17
Volume[144] (cm^3)	11	8.5	7.9
Power Source	1 lithium iodine cell	1 lithium iodine cell	1 lithium iodine cell
Manufacturer	Greatbatch Medical, Model WG 9438	Greatbatch Medical, Model WG 9918	Greatbatch Medical, Model WG 9918

[136] Standard settings are in bold face.
[137] Atrial setting is not available in VDD(R) mode.
[138] During atrial NIPS in dual-chamber modes, the shortest Coupling Interval will be limited by the programmed Paced/Sensed AV Delay.
[139] S1 Burst Cycle is applied at the preprogrammed S1 cycle length.
[140] The standard setting for S2, S3, and S4 is Off.
[141] Not available in single-chamber modes.
[142] These values are nominal.
[143] These values are nominal.
[144] ± 0.5 cm^3.

Table 34. Physical specifications for Victory devices

	5816	5810	5610
Lead Connector	IS-1 compatible[145]	IS-I[146]	IS-I[147]
X-ray ID Code	VW	VW	VW

[145] Accepts all IS-1, VS•1, and 3.2 mm leads.
[146] Accepts only IS-1 (short pin) leads.
[147] Accepts only IS-1 (short pin) leads.

Appendix C. Zephyr™ Devices Technical Data

The technical data below include:

Zephyr™ Dual-Chamber Devices (Models 5826, 5820)

Shipped, Emergency VVI, and Standard Settings

Table 35. Shipped, Emergency VVI, and Standard settings for Zephyr dual-chamber devices (Models 5826, 5820)

Parameter	Shipped Settings	Emergency VII Settings	Standard (Nominal) Settings[148]
Basic Operation			
Mode	DDD	VVI	DDD
Magnet Response	Battery Test	Battery Test	Battery Test
Sensor	Passive	Off	Passive
Max Sensor Rate	130 min^{-1}	No Change	130 min^{-1}
Threshold	Auto (+ 0.0)	No Change	Auto (+ 0.0)
Slope	Auto (+2)	No Change	Auto (+2)
Reaction Time	Fast	No Change	Fast
Recovery Time	Medium	No Change	Medium
Rates			
Base Rate	60 min^{-1}	70 min^{-1}	60 min^{-1}
Rest Rate	Off	Off	Off
Max Tracking Rate	130 min^{-1}	-	130 min^{-1}
Hysteresis Rate	Off	Off	Off
Search Interval	-	-	5 min
Cycle Count	-	-	1
Intervention Rate	-	-	Off
Intervention Duration	-	-	3 min
Recovery Time	-	-	Medium
Delays			
Paced AV Delay	200 ms	-	200 ms
Sensed AV Delay	150 ms	-	150 ms
Rate Responsive AV Delay	Off	-	Off
Shortest AV Delay	100 ms	-	100 ms
Ventricular Intrinsic Preference (VIP™)	Off	-	Off
VIP Search Interval	-	-	1 min
VIP Search Cycles	-	-	1 cycle
Negative AV/PV Hysteresis w/Search	Off	-	Off
Capture & Sense			
ACap™ Confirm	Off	Off	Off
V. AutoCapture™	Off	Off	Off
A, Pulse Amplitude	2.5 V	-	2.5 V
V. Pulse Amplitude	2.5 V	7.5 V	2.5 V

[148] If parameters have not been previously programmed and are not autoprogrammed, the device will institute these standard or nominal settings.

Table 35. Shipped, Emergency VVI, and Standard settings for Zephyr dual-chamber devices (Models 5826, 5820)

Parameter	Shipped Settings	Emergency VII Settings	Standard (Nominal) Settings[148]
A. Pulse Width	0.4 ms	-	0.4 ms
V. Pulse Width	0.4 ms	0.6 ms	0.4 ms
A. Amplitude Monitoring	On	No Change	On
V. Amplitude Monitoring	On	No Change	On
A. Sensitivity	0.5 mV	-	0.5 mV
V. Sensitivity	2.0 mV	2.0 mV	2.0 mV
AutoCapture			
A. Backup Pulse Configuration	-	-	Bipolar
V. Backup Pulse Configuration	-	-	Bipolar
A. Search Frequency	-	-	8 hrs
V. Search Frequency	-	-	8 hrs
V. AutoCapture Paced/Sensed AV Delay	-	-	50/25 ms
Leads			
A. Lead Type	Uncoded	No Change	Uncoded
V. Lead Type	Uncoded	No Change	Uncoded
A. Pulse Configuration	See Package Label	-	See Package Label
V. Pulse Configuration	See Package Label	Unipolar[149]	See Package Label
A. Sense Configuration	See Package Label	-	See Package Label
V. Sense Configuration	See Package Label	Unipolar Tip[150]	See Package Label
A. Lead Monitoring	Off *	-	Off *
V. Lead Monitoring	Off *	No Change	Off *
V. Upper Limit	-	No Change	2000 Ω
Refractories & Blanking			
A. Refractory (PVARP)	275 ms	-	275 ms
A. Absolute Refractory Period[151]	-	No Change	60 ms
V. Refractory	250 ms	325 ms	250 ms
Rate Responsive PVARP/VREF	Low	Off	Low
Shortest PVARP/VREF	170 ms	-	170 ms
Post Ventricular Atrial Blanking (PVAB)	150 ms	-	150 ms
V. Blanking	Auto	-	Auto
V. Safety Standby	On	-	On
PVC Options	A Pace on PVC[152]	-	A Pace on PVC[153]
PMT Options	Auto Detect	-	Auto Detect
PMT Detection Rate	110 min^{-1}	-	110 min^{-1}
AT/AF Detection & Response			
Auto Mode Switch	DDIR	-	DDIR
Atrial Tachycardia Detection Rate	180 min^{-1}		180 min^{-1}
AMS Base Rate	80 min^{-1}	-	80 min^{-1}
AF Suppression™	Off	-	Off
Overdrive Pacing Cycles	-	-	15 cycles
Maximum AF Suppression Rate	-	-	120 min^{-1}

* Once the device detects the presence of a lead, the setting automatically switches from Off to Monitor.

[149] If the Lead Type parameter is programmed to "Bipolar Only," the Emergency VVI setting will be Bipolar.
[150] If the Lead Type parameter is programmed to "Bipolar Only," the Emergency VVI setting will be Bipolar.
[151] Only available in AAI(R) and AAT(R) modes.
[152] In VDD mode, the setting is +PVARP on PVC.
[153] In VDD mode, the setting is +PVARP on PVC.

Programmable Parameters, Settings, and Tolerances

Table 36. Programmable parameters, settings, and tolerances for Zephyr dual-chamber devices (Models 5826, 5820)

Parameter	Settings	Units	Tolerance
Basic Operation			
Mode	AOO(R); AAI (R); AAT(R); OAO; VOO(R); VVI(R); VVT(R); VDD(R); OVO; DOO(R); DVI(R); DDI(R); DDD(R); ODO	n/a	n/a
Magnet Response	Off; Battery Test	n/a	n/a
Sensor	On; Off; Passive	n/a	n/a
Max Sensor Rate	80 – 150 in steps of 5; 160 – 180 in steps of 10	min^{-1}	± 16ms
Threshold	1 – 7 in steps of 0.5; Auto (-0.5); Auto (+0.0); Auto (+0.5); Auto (+1.0); Auto (+1.5); Auto (+2.0)	n/a	n/a
Slope	1 – 16; Auto (-1); Auto (+0); Auto (+1); Auto (+2); Auto (+3)	n/a	n/a
Reaction Time	Very Fast; Fast; Medium; Slow	n/a	n/a
Recovery Time	Fast; Medium; Slow; Very Slow	n/a	n/a
Rates			
Base Rate	30[154]; 40 – 130 in steps of 5; 140 – 170 in steps of 10	min^{-1}	+ 30/- 8 ms
Rest Rate	Off; 30 – 130 in steps of 5; 140; 150	min^{-1}	± 16 ms
Max Tracking Rate	90 – 130 in steps of 5; 140 – 180 in steps of 10	min^{-1}	± 16 ms
Hysteresis Rate[155]	Off; 30 – 130 in steps of 5; 140; 150	min^{-1}	+ 25/- 8 ms
Search Interval	Off; 5; 10; 15; 30	min	± 4 sec
Cycle Count	1-16	cycles	n/a
Intervention Rate	Off; Base Rate; Intrinsic+0; Intrinsic+10; Intrinsic+20; Intrinsic+30; 80 – 120 in steps of 10[156]	min^{-1}	± 16 ms[157]
Intervention Duration	1 – 10	min	± 4 sec
Recovery Time	Fast; Medium; Slow; Very Slow	n/a	n/a
Delays			
Paced AV Delay	25; 30 – 200 in steps of 10; 225 – 300 in steps of 25; 350	ms	± 16
Sensed AV Delay	25; 30 – 200 in steps of 10; 225 – 325 in steps of 25	ms	+ 25/- 8
Rate Responsive AV Delay	Off; Low (1); Medium (2); High (3)	ms/min^{-1}	± 16 ms
Shortest AV Delay	30 – 50 in steps of 5; 60 – 120 in steps of 10	ms	± 16
Ventricular Intrinsic Preference (VIP™)	Off; 50; 75; 100; 125; 150; 160; 170; 180; 190; 200	ms	± 8
VIP Search Interval	30 sec; 1, 3, 5, 10, 30 min	sec; min	± 4 sec
VIP Search Cycles	1; 2; 3	n/a	cycles
Negative AV Hysteresis w/Search	Off; -10 to -110 in steps of 10	ms	± 8
Capture & Sense			
ACap™ Confirm	On; Monitor; Off	n/a	n/a
V. AutoCapture™	On; Off	n/a	n/a

[154] The actual pacing rate for the 30 min-1 setting is 31 min-1.
[155] The highest available setting for the Hysteresis Rate parameter will be 5 min-1 below the programmed Base Rate parameter.
[156] If the Base Rate parameter is programmed lower than 60 min-1, the lowest available Intervention Rate setting is 60 min-1.
[157] Tolerance is for fixed values. For intrinsic values, the tolerance is ± 5 min-1.

Table 36. Programmable parameters, settings, and tolerances for Zephyr dual-chamber devices (Models 5826, 5820)

Parameter	Settings	Units	Tolerance
A. Pulse Amplitude	0.0 – 4.0 in steps of 0.25; 4.5 – 7.5 in steps of 0.5	V	± 30%[158]
V. Pulse Amplitude	0.0 – 4.0 in steps of 0.25; 4.5 – 7.5 in steps of 0.5	V	± 30%[159]
A. Pulse Width	0.05; 0.1 – 1.5 in steps of 0.1	ms	± 0.04
V. Pulse Width	0.05; 0.1 - 1.5 in steps of 0.1	ms	± 0.04
A. Amplitude Monitoring	On; Off	n/a	n/a
V. Amplitude Monitoring	On; Off	n/a	n/a
A. Sensitivity[160]	0.1 *; 0.2 *; 0.3 *; 0.4 *; 0.5; 0.75; 1.0; 1.25; 1.5; 1.75; 2.0; 2.5; 3.0; 3.5; 4.0; 5.0	mV	± 30%[161]
V. Sensitivity[162]	0.5 – 5.0 in steps of 0.5; 6 – 10 in steps of 1.0; 12.5	mV	± 30%[163]
AutoCapture			
A. Backup Pulse Configuration	Unipolar; Bipolar	n/a	n/a
V. Backup Pulse Configuration	Unipolar; Bipolar	n/a	n/a
A. Search Frequency	8; 24	hrs	± 30 sec
V. Search Frequency	8; 24	hrs	± 30 sec
V. AutoCapture Paced/Sensed AV Delay	120/100; 100/70; 50/25	ms/ms	± 8
Leads			
A. Lead Type	Uncoded; Unipolar; Bipolar Only; Uni/Bi	n/a	n/a
V. Lead Type	Uncoded; Unipolar; Bipolar Only; Uni/Bi	n/a	n/a
A. Pulse Configuration	Unipolar (tip-case); Bipolar (tip-ring)	n/a	n/a
V. Pulse Configuration	Unipolar (tip-case); Bipolar (tip-ring)	n/a	n/a
A. Sense Configuration	Unipolar Tip (tip-case); Bipolar (tip-ring); Unipolar Ring (ring-case)	n/a	n/a
V. Sense Configuration	Unipolar Tip (tip-case); Bipolar (tip-ring); Unipolar Ring (ring-case)	n/a	n/a
A. Lead Monitoring	Off; Monitor; Polarity Switch	n/a	n/a
V. Lead Monitoring	Off; Monitor; Polarity Switch	n/a	n/a
V. Upper Limit	750, 1000, 1250, 1500, 1750, 2000	Ω	±15%
Refractories & Blanking			
A. Refractory (PVARP)	125 – 500 in steps of 25	ms	± 16
A. Absolute Refractory Period[164]	60; 80; 100 – 350 in steps of 25	ms	± 16
V. Refractory[165]	125 – 500 in steps of 25	ms	± 16
Rate Responsive PVARP/VREF	Off; Low (1); Medium (2); High (3)	ms/min^{-1}	± 16 ms
Shortest PVARP/VREF	120 – 350 in steps of 10	ms	± 16
Post Ventricular Atrial Blanking (PVAB)	60; 70; 80; 85; 95; 100; 110; 115; 125; 130; 140; 150; 155; 165; 170; 180; 185; 195; 200	ms	± 16

[158] Tolerances are measured against impedances 500 W and above. For the 0.0 V setting, the tolerance is 0 – 75 mV.
[159] Tolerances are measured against impedances 500 W and above. For the 0.0 V setting, the tolerance is 0 – 75 mV.
[160] Sensitivity is with respect to a 20 ms haversine test signal.
[161] For settings of 0.75 mV and below, tolerance is ± 50%.
[162] Sensitivity is with respect to a 20 ms haversine test signal.
[163] For 0.5 mV setting, tolerance is ± 50%.
[164] Only available in AAI(R) and AAT(R) modes.
[165] In dual-chamber modes, the maximum V. Refractory Period is 325 ms.

Table 36. Programmable parameters, settings, and tolerances for Zephyr dual-chamber devices (Models 5826, 5820)

Parameter	Settings	Units	Tolerance
V. Blanking	Auto; 12 – 52 in steps of 4	ms	± 8
V. Safety Standby	Off; On	n/a	n/a
PVC Options	Off; A Pace on PVC; +PVARP on PVC[166]	n/a	n/a
PMT Options	Off; 10 Beats > PMT; Auto Detect	n/a	n/a
PMT Detection Rate	90 – 150 in steps of 5; 160 – 180 in steps of 10	min^{-1}	± 16 ms
AT/AF Detection & Response			
Auto Mode Switch	Off; DDD to DDI; DDD to DDIR; DDDR to DDI; DDDR to DDIR; VDD to VVI; VDD to VVIR; VDDR to VVI; VDDR to VVIR	n/a	n/a
Atrial Tachycardia Detection Rate	110 – 150 in steps of 5; 160 – 200 in steps of 10; 225 – 300 in steps of 25	min^{-1}	± 16 ms
AMS Base Rate	Base Rate +0 to Base Rate +35 in steps of 5[167]	min^{-1}	± 16 ms
AF Suppression™	On; Off	n/a	n/a
Maximum AF Suppression Rate	80 — 150 in steps of 5; 160; 170; 180	min^{-1}	± 16 ms
Overdrive Pacing Cycles	15 – 40 in steps of 5	cycles	n/a

* Except in VDD(R), settings 0.1 to 0.4 mV are not available when A. Sense Configuration is set to Unipolar.

Zephyr™ Single-Chamber Devices (Models 5626, 5620)

Shipped, Emergency VVI, and Standard Settings

Table 37. Shipped, Emergency VVI, and Standard settings for Zephyr single-chamber devices (Models 5626, 5620)

Parameter	Shipped Settings	Emergency VII Settings	Standard (Nominal) Settings[168]
Basic Operation			
Mode	VVI	VVI	VVI
Magnet Response	Battery Test	Battery Test	Battery Test
Sensor	Passive	Off	Passive
Max Sensor Rate	130 min^{-1}	No Change	130 min^{-1}
Threshold	Auto (+ 0.0)	No Change	Auto (+ 0.0)
Slope	Auto (+2)	No Change	Auto (+2)
Reaction Time	Fast	No Change	Fast
Recovery Time	Medium	No Change	Medium
Rates			
Base Rate	60 min^{-1}	70 min^{-1}	60 min^{-1}
Rest Rate	Off	Off	Off
Hysteresis Rate	Off	Off	Off
Search Interval	-	-	Off[169]
Cycle Count	-	-	1
Intervention Rate	-	-	Off
Intervention Duration	-	-	3 min
Recovery Time	-	-	Medium
Capture & Sense			

[166] Only available in VDD(R) modes.
[167] These represent formulas for computing AMS Base Rate settings. Actual settings appear as numerical rates.
[168] If parameters have not been previously programmed and are not autoprogrammed, the device will institute these standard or nominal settings.
[169] When the Intervention Duration parameter is programmed On, the Search Interval is autoprogrammed to a standard setting of 5 min.

Table 37. Shipped, Emergency VVI, and Standard settings for Zephyr single-chamber devices (Models 5626, 5620)

Parameter	Shipped Settings	Emergency VII Settings	Standard (Nominal) Settings[168]
V. AutoCapture™	Off	Off	Off
Pulse Amplitude	2.5 V	7.5 V	2.5 V
Pulse Width	0.4 ms	0.6 ms	0.4 ms
Amplitude Monitoring	On	No Change	On
Sensitivity	2.0 mV	2.0 mV	2.0 mV
Backup Pulse Configuration	-	-	Bipolar
Search Frequency	-	-	8 hrs
Leads			
Lead Type	Uncoded	No Change	Uncoded
Pulse Configuration	See Package Label	Unipolar[170]	See Package Label
Sense Configuration	See Package Label	Unipolar Tip[171]	See Package Label
Lead Monitoring	Off[172]	No Change	Off[173]
Upper Limit	2000 Ω	No Change	2000 Ω
Refractories & Blanking			
Refractory	325 ms	325 ms	325 ms
Rate Responsive AREF/VREF	Off	Off	Off
Shortest AREF/VREF	-	-	200 ms

Programmable Parameters, Settings, and Tolerances

Table 38. Programmable parameters, settings, and tolerances for Zephyr single-chamber devices (Models 5626, 5620)

Parameter	Settings	Units	Tolerance
Basic Operation			
Mode	AOO(R); AAI(R); AAT(R); OAO; VOO(R); VVI(R); VVT(R); OVO	n/a	n/a
Magnet Response	Off; Battery Test	n/a	n/a
Sensor	On; Off; Passive	n/a	n/a
Max Sensor Rate	80 – 150 in steps of 5; 160 – 180 in steps of 10	min^{-1}	± 16ms
Threshold	1 – 7 in steps of 0.5; Auto (-0.5); Auto (+0.0); Auto (+0.5); Auto (+1.0); Auto (+1.5); Auto (+2.0)	n/a	n/a
Slope	1 – 16; Auto (-1); Auto (+0); Auto (+1); Auto (+2); Auto (+3)	n/a	n/a
Reaction Time	Very Fast; Fast; Medium; Slow	n/a	n/a
Recovery Time	Fast; Medium; Slow; Very Slow	n/a	n/a
Rates			
Base Rate	30[174]; 40 – 130 in steps of 5; 140 – 170 in steps of 10	min^{-1}	+ 30/- 8 ms
Rest Rate	Off; 30 – 130 in steps of 5; 140; 150	min^{-1}	± 16 ms
Hysteresis Rate[175]	Off; 30 – 130 in steps of 5; 140; 150	min^{-1}	+ 25/- 8 ms
Search Interval	Off; 5; 10; 15; 30	min	± 4 sec
Cycle Count	1 – 16	cycles	n/a

[170] If the Lead Type parameter is programmed to "Bipolar Only," the Emergency VVI setting will be Bipolar.
[171] If the Lead Type parameter is programmed to "Bipolar Only," the Emergency VVI setting will be Bipolar.
[172] Once the device detects the presence of a lead, the setting automatically switches from Off to Monitor.
[173] Once the device detects the presence of a lead, the setting automatically switches from Off to Monitor.
[174] The actual pacing rate for the 30 min-1 setting is 31 min-1.
[175] The highest available setting for the Hysteresis Rate parameter will be 5 min-1 below the programmed Base Rate parameter.

Table 38. Programmable parameters, settings, and tolerances for Zephyr single-chamber devices (Models 5626, 5620)

Parameter	Settings	Units	Tolerance
Intervention Rate	Off; Base Rate; Intrinsic+0; Intrinsic+10; Intrinsic+20; Intrinsic+30; 80 – 120 in steps of 10[176]	**min^{-1}**	± 16 ms[177]
Intervention Duration	1 – 10	min	± 4 sec
Recovery Time	Fast; Medium; Slow; Very Slow	n/a	n/a
Capture & Sense			
V. AutoCapture™	On; Off	n/a	n/a
Pulse Amplitude	0.0 – 4.0 in steps of 0.25; 4.5 – 7.5 in steps of 0.5	V	± 30%[178]
Pulse Width	0.05; 0.1 – 1.5 in steps of 0.1	ms	± 0.04
Sensitivity[179]	0.5 – 5.0 in steps of 0.5; 6 – 10 in steps of 1.0; 12.5	mV	± 30%[180]
Amplitude Monitoring	On; Off	n/a	n/a
Backup Pulse Configuration	Unipolar; Bipolar	n/a	n/a
Search Frequency	8; 24	hrs	n/a
Leads			
Lead Type	Uncoded; A. Unipolar; V. Unipolar; A. Bipolar Only; V. Bipolar Only; A. Uni/Bi; V. Uni/Bi	n/a	n/a
Pulse Configuration	Unipolar (tip-case); Bipolar (tip-ring)	n/a	n/a
Sense Configuration	Unipolar Tip (tip-case); Bipolar (tip-ring); Unipolar Ring (ring-case)	n/a	n/a
Lead Monitoring	Off; Monitor; Polarity Switch	n/a	n/a
Upper Limit	750; 1000; 1250; 1500; 1750; 2000	Ω	±15%
Refractories & Blanking			
Refractory	125 – 500 in steps of 25	ms	± 16
Rate Responsive AREF/VREF	Off; Low (1); Medium (2); High (3)	ms/**min^{-1}**	± 16 ms
Shortest AREF/VREF	120 – 350 in steps of 10	ms	± 16

Episode Configuration and Trigger Settings

Table 39. Episode Configuration and Trigger settings for Zephyr devices

Parameter	Settings[181]	Units	Tolerance
Configuration			
Sampling Options	**Freeze;** Continuous	n/a	n/a
No. of Stored Episodes	1; 2; **4;** 8; 12	n/a	n/a
Channel	Single; **Dual**[182]	n/a	n/a
EGM Configuration[183]	**V Bipolar**; V Unipolar Tip; V Unipolar Ring; Atip-Vtip; Aring-Vtip; Aring-Vring; A Bipolar; A Unipolar Tip; A Unipolar Ring	n/a	n/a
EGM Recording Range	± 15.0; ± 7.5; **± 3.0**; ± 1.5	mV	± 20%

[176] If the Base Rate parameter is programmed lower than 60 min-1, the lowest available Intervention Rate setting is 60 min-1.
[177] Tolerance is for fixed values. For intrinsic values, the tolerance is ± 5 min-1.
[178] Tolerances are measured against impedances 500 W and above. For the 0.0 V setting, the tolerance is 0 – 75 mV.
[179] Sensitivity is with respect to a 20 ms haversine test signal.
[180] For 0.5 mV setting, tolerance is ± 50%.
[181] Standard settings are in bold face.
[182] The standard setting for single-chamber modes is Single.
[183] These settings are available when the Channel parameter is set to Single and when both Lead Type parameters are set to either Uni/Bi or Bipolar. For more information, see EGM Configuration.

Table 39. Episode Configuration and Trigger settings for Zephyr devices

Parameter	Settings[181]	Units	Tolerance
A. EGM Configuration[184]	**A Bipolar**; A Unipolar Tip; A Unipolar Ring; Atip-Vtip; Aring-Vtip	n/a	n/a
A. EGM Recording Range	± 15.0; ± 7.5; **± 3.0**; ± 1.5	mV	± 20%
V. EGM Configuration **	**V Bipolar**; V Unipolar Tip; V Unipolar Ring; Atip-Vtip; Aring-Vtip; Aring-Vring	n/a	n/a
V. EGM Recording Range	**± 15.0**; ± 7.5; ± 3.0; ± 1.5	mV	± 20%
Episode Triggers			
Atrial Trigger	AT/AF; High Atrial Rate; AMS *; **Off**	n/a	n/a
Trigger Type	Entry & Exit; Exit; **Entry**	n/a	n/a
High A. Rate Trigger	**Off**; 125 – 300 in steps of 25	**min^{-1}**	± 16 ms
Consecutive Cycles	2; 3; 4; **5**; 10; 15; 20	n/a	n/a
High V. Rate Trigger	**Off**; 125 – 300 in steps of 25	**min^{-1}**	± 16 ms
Consecutive Cycles	2; 3; 4; **5**; 10; 15; 20	n/a	n/a
PVC Trigger *	On; **Off**	n/a	n/a
Consecutive PVCs *	**2**; 3; 4; 5	n/a	n/a
Advanced Hysteresis Trigger	On; **Off**	n/a	n/a
PMT Detection Trigger *	On; **Off**	n/a	n/a
Magnet Placement Trigger	On; **Off**	n/a	n/a

* Not available in single chamber modes.

** These settings are available when the V. Lead Type parameter is set to Uni/Bi or Bipolar Only and the Channel parameter is set to Dual. If the V. Lead Type is Unipolar, then the standard setting is V Unipolar Tip. If the V. Lead Type parameter is set to Single-Pass VDD, the options are: Vring-Adist; Vring-Aprox; Vtip-Adist; Vtip-Aprox; V Unipolar Ring; V Bipolar; V Unipolar Tip; Aprox-Vtip; Aprox-Case; Aprox-Vring; Adist-Aprox; Adist-Vtip; Adist-Case; Adist-Vring. (Atrial Standard is Adist-Vring; Ventricular Standard is V Bipolar.) For more information, see EGM Configuration.

NIPS Options

Table 40. NIPS options for Zephyr devices

Parameter	Settings[185]	Units	Tolerance
Stimulation Chamber	**Atrial**[186]; Ventricular	n/a	n/a
Coupling Interval[187]	100 – 800 in steps of 10 **(500)**	ms	± 8
S1 Count	1 – 25 in steps of 1 **(8)**	n/a	n/a
S1[188], S2, S3, and S4 Cycle	Off; 100 – 800 in steps of 10 **(500)**[189]	ms	± 6
V. Backup Rate (VOO Pacing)[190]	Off; 30; 40 – 95 in steps of 5 **(50)**	**min^{-1}**	± 30 ms
Sinus Node Recovery Delay	**1** – 5 in steps of 1	sec	± 100 ms

Physical Specifications

Table 41. Physical specifications for Zephyr devices

	5826	5820	5626	5620
Case Material	Titanium	Titanium	Titanium	Titanium
Case Coating	Uncoated	Uncoated	Uncoated	Uncoated

[184] These settings are available when the A. Lead Type parameter is set to Uni/Bi or Bipolar Only and the Channel parameter is set to Dual. If the A. Lead Type is Unipolar, then the standard setting is A Unipolar Tip. For more information, see EGM Configuration.
[185] Standard settings are in bold face.
[186] Atrial setting is not available in VDD(R) mode.
[187] During atrial NIPS in dual-chamber modes, the shortest Coupling Interval will be limited by the programmed Paced/Sensed AV Delay.
[188] S1 Burst Cycle is applied at the preprogrammed S1 cycle length.
[189] The standard setting for S2, S3, and S4 is Off.
[190] Not available in single-chamber modes.

Table 41. Physical specifications for Zephyr devices

	5826	5820	5626	5620
Connector Material	Composite Polymer	Composite Polymer	Composite Polymer	Composite Polymer
Dimensions [191](mm)	44(h) x 52(l) x 6(t)	43(h) x 44(l) x 6(t)	42(h) x 52(l) x 6(t)	41(h) x 44(l) x 6(h)
Weight [192](g)	23.5	18	23	17
Volume[193] (cm^3)	11	8.5	10.4	7.9
Power Source	1 lithium iodine cell	1 lithium iodine cell	1 lithium iodine cell	1 lithium iodine cell
Manufacturer	Wilson Greatbatch, Model WG 9438	Wilson Greatbatch, Model WG 9918	Wilson Greatbatch, Model WG 9438	Wilson Greatbatch, Model WG 9918
Lead Connector	IS-1 compatible[194]	IS-I[195]	IS-1 compatible[196]	IS-I[197]
X-ray ID Code	VW	VW	VW	VW

[191] These values are nominal.
[192] These values are nominal.
[193] ± 0.5 cm^3.
[194] Accepts all IS-1, VS•1, and 3.2 mm leads.
[195] Accepts only IS-1 (short pin) leads.
[196] Accepts all IS-1, VS•1, and 3.2 mm leads.
[197] Accepts only IS-1 (short pin) leads.

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