

Pacemaker Counter and Histogram Operation & Interpretation

SUMMARY

This article provides further information regarding the operation and interpretation of Event Counters and Histograms available in ALTRUA™, INSIGNIA®, PULSAR® MAX II, and DISCOVERY® II pacemakers.

The **Event Counters** feature counts, records, and displays a variety of data, including the total number of paced and sensed events. The **Histograms** feature displays a graphical representation of the counter data and provides the amount of time spent pacing and sensing at various rates. **Event Counters** and **Histograms** are available by selecting Therapy History on the ZOOM® LATITUDE® Programmer.

Counters

The **Paced and Sensed Event Counters** (Figure 1) record the number of intrinsic and paced events that occur during an event recording period. This period begins with the last time the **Counters** were reset by the clinician and ends when the data are retrieved from the pacemaker during a telemetry session.

Three sets of pace/sense event counters are available for review (Figure 2) by pressing the Paced and Sensed Details icon:

1. **Atrial-only events**
2. **Ventricular-only events**
3. **Combination A-V events**

NOTE: These data are provided as both a percentage of the total events and a total count since the last reset (Figure 2).

CRM PRODUCTS REFERENCED

The following are trademarks of Cardiac Pacemakers Inc., a Boston Scientific company: PULSAR MAX II, DISCOVERY II, INSIGNIA, and ALTRUA pacemakers, and the ZOOM LATITUDE programmer.

Products referenced herein may not be approved in all geographies. For comprehensive information on device operation, reference the appropriate product labeling.

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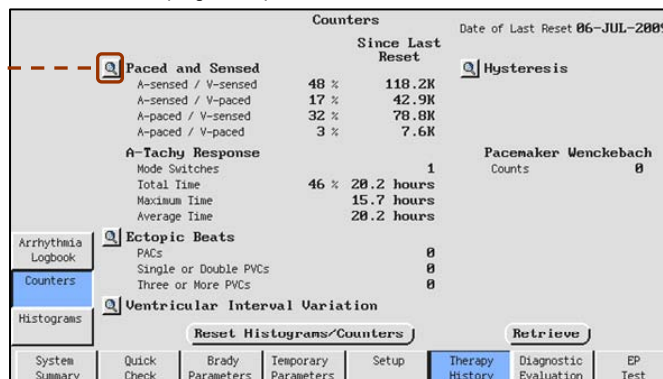


Figure 1. ALTRUA® Counters.

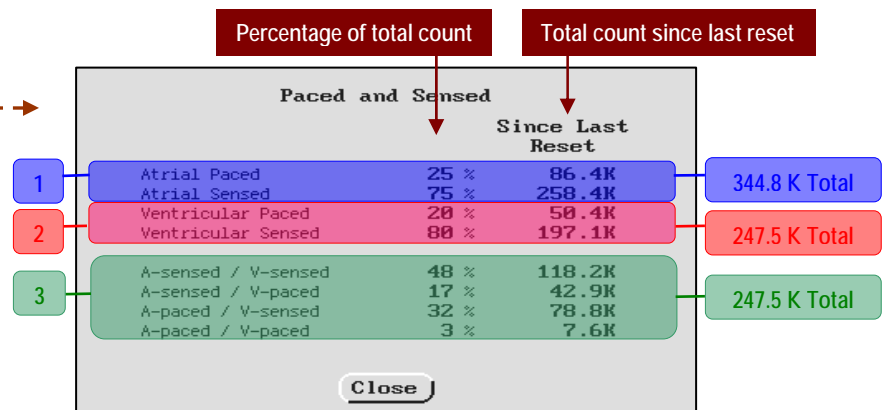


Figure 2. ALTRUA detailed Paced and Sensed Counters.

Events Counted

The following events are counted:

- **Atrial-only events:** Counted from the atrial channel and assigned to either the paced or sensed bin.
- **Ventricular-only events:** Counted from the ventricular channel and assigned to either the paced or sensed bin.
- **Combination A-V events:** Counted from the ventricular channel, and then categorized based upon the preceding atrial event:
 - First, the ventricular event is designated as either paced or sensed.
 - Next, the atrial event immediately preceding the ventricular event is classified as either paced or sensed.
 - Finally, the overall A-V combination is assigned to one of four possible A-V pace/sense bins (Figure 2).

Comparing Counter Data

When evaluating counter data, the following should be considered:

- The total of the combination A-V event counters will *always* match the total of the ventricular-only event counters because both are counted from the same ventricular events (Figure 2).
- The total of the combination A-V event counters will not match the total of the atrial-only event counters unless there is perfect 1:1 A-V conduction in dual-chamber mode. In this scenario, every ventricular event is preceded by one and only one atrial event, making counters equal.
- The total of the combination A-V event counters will occasionally not match the total of the atrial-only counters because the atrium and the ventricle often work independent of each other (Figure 2). Examples of common situations resulting in dissociation of the counters include:
 - Atrial arrhythmias (more than one A event for each V event)
 - Ventricular arrhythmias (more than one V event for each A event)

NOTE: PVCs are not included in the ventricular pace/sense counters; instead, they have their own separate counters.

 - Programming the device to a single-chamber mode—AAI(R) or VVI(R)

Table 1 provides counter results that may be observed in the clinical setting.

Table 1. Examples of Counter Results in Various Programmed Modes																															
Example 1	A dual-chamber device programmed to DDI(R) in a patient with frequent atrial fibrillation																														
A large number of atrial-sensed events are recorded as a result of the patient's atrial fibrillation. These data are not represented in the combination A-V event counters since the combination A-V event counter recognizes only the single atrial event immediately preceding the associated ventricular event.																															
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center;">Paced and Sensed</th> <th style="text-align: center;">Since Last Reset</th> </tr> </thead> <tbody> <tr> <td>Atrial Paced</td> <td style="text-align: right;">35 %</td> <td style="text-align: right;">990.0K</td> </tr> <tr> <td>Atrial Sensed</td> <td style="text-align: right;">65 %</td> <td style="text-align: right; border: 1px solid red;">3.8M</td> </tr> <tr> <td>Ventricular Paced</td> <td style="text-align: right;">100 %</td> <td style="text-align: right;">1.2M</td> </tr> <tr> <td>Ventricular Sensed</td> <td style="text-align: right;">0 %</td> <td style="text-align: right;">0</td> </tr> <tr> <td colspan="3"> </td> </tr> <tr> <td>A-sensed / V-sensed</td> <td style="text-align: right;">16 %</td> <td style="text-align: right;">190.0K</td> </tr> <tr> <td>A-sensed / V-paced</td> <td style="text-align: right;">0 %</td> <td style="text-align: right;">0</td> </tr> <tr> <td>A-paced / V-sensed</td> <td style="text-align: right;">0 %</td> <td style="text-align: right;">0</td> </tr> <tr> <td>A-paced / V-paced</td> <td style="text-align: right;">84 %</td> <td style="text-align: right; border: 1px solid red;">990.0K</td> </tr> </tbody> </table>		Paced and Sensed		Since Last Reset	Atrial Paced	35 %	990.0K	Atrial Sensed	65 %	3.8M	Ventricular Paced	100 %	1.2M	Ventricular Sensed	0 %	0				A-sensed / V-sensed	16 %	190.0K	A-sensed / V-paced	0 %	0	A-paced / V-sensed	0 %	0	A-paced / V-paced	84 %	990.0K
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Example 2 | A dual-chamber device programmed to VVI(R) mode

While the device is operating in VVI mode, the A-V event counters are populated even though a lack of atrial sensing prevents classification of combination A-V events. This is because both count ventricular-only events. As a default, the ventricular events are binned as having been preceded by atrial sensed events, even though no atrial data have been collected. Nevertheless, both totals are fully accurate. In addition, note that the totals are also equal.

Paced and Sensed		Since Last Reset
Atrial Paced	0 %	0
Atrial Sensed	0 %	0
Ventricular Paced	62 %	231.4K
Ventricular Sensed	38 %	141.8K
A-sensed / V-sensed	38 %	141.8K
A-sensed / V-paced	62 %	231.4K
A-paced / V-sensed	0 %	0
A-paced / V-paced	0 %	0

In VVI mode, the V counters match the Combination A-V counters since the source data are the same.

Example 3 | A dual-chamber device programmed to AAI(R) mode

While the device is operating in AAI mode, the A-V event counters are not populated, because they count ventricular activity.

Paced and Sensed		Since Last Reset
Atrial Paced	91 %	182K
Atrial Sensed	9 %	18K
Ventricular Paced	0 %	0
Ventricular Sensed	0 %	0
A-sensed / V-sensed	0 %	0
A-sensed / V-paced	0 %	0
A-paced / V-sensed	0 %	0
A-paced / V-paced	0 %	0

V counters and Combination A-V counters are populated with "0" when device is programmed to AAI Mode.

Histograms

Histograms provide a graphical representation of the atrial and ventricular paced and sensed events collected during the recording period. This information may facilitate diagnostic interpretation of cardiac activity.

Events are sorted into rate bins on the Histograms, with two different options for displaying the data:

1. **A-V Histograms**—shows the type of ventricular events (paced or sensed) that follow atrial activity (Figure 6).
 - The maximum Y-axis scale value (50% or 100%) is automatically determined by the maximum value in either the Ventricular Paced/Ventricular Sensed bins (displayed on the **Pace/Sense Histograms**) or the Atrial Paced VP/VS bins (displayed on the **A-V Histograms**)
2. **Pace/Sense Histograms**—shows atrial paced and sensed events and ventricular paced and sensed events (Figure 7).
 - The maximum Y-axis scale value (50% or 100%) is automatically determined by the maximum value in any of the Atrial or Ventricular bins (displayed on the **Pace/Sense Histograms**).

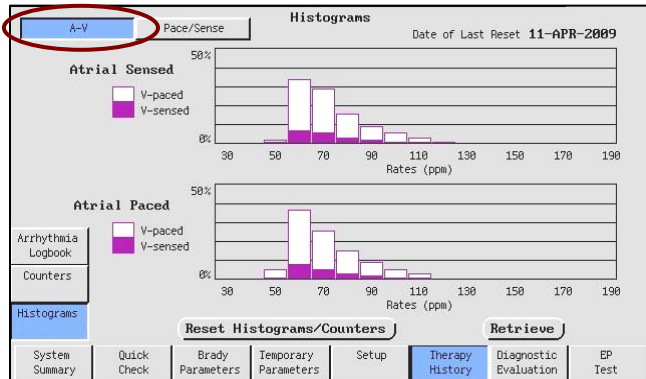


Figure 6. ALTRUA A-V Histograms.

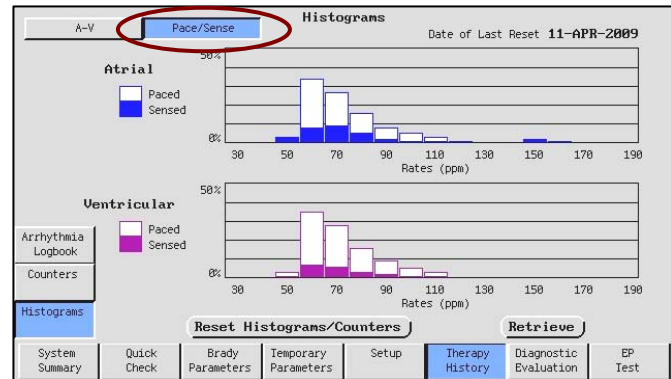


Figure 7. ALTRUA Pace/Sense Histograms.

When the **A-V Histograms** are printed (Figure 8) it is possible to see an Atrial Sensed histogram bar extend beyond the chart boundaries. This will occur **only if**:

1. The highest value of Ventricular Paced/Ventricular Sensed or Atrial Paced VP/VS events at any given rate is less than 50%, setting the maximum Y-axis scale value to 50% (rather than 100%), **AND**
2. Atrial sensed VP/VS events occur with a frequency greater than 50% at any given rate. Because this value is greater than the set Y-axis scale value of 50%, the histogram bar will appear above the previously scaled Y-axis.

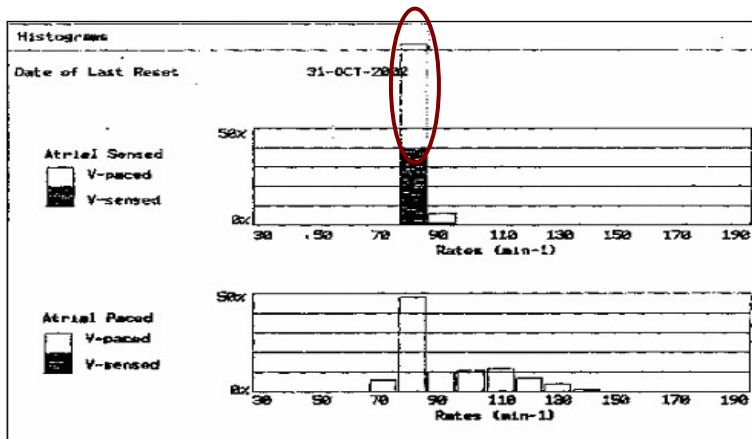


Figure 8. A-V Histograms Printout.

In this situation, the printed histogram differs from the histogram displayed on the programmer.

- Programmer screen: the bar noted above is automatically truncated and will not extend beyond the top of the grid.
- Printout: the *actual* pacing percentage will be displayed, by going beyond 50%. **Counters** will also display the *actual* pacing percentage.

NOTE: This Y-axis scaling will not occur with the **Pace/Sense Histograms** because scale selection is based solely on a single maximum count (no combinations).