

InterSim III

Release I/2025

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Conduction System Pacing

Introduction

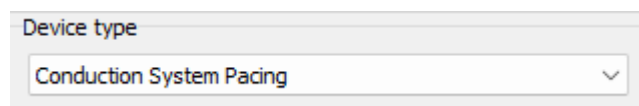
Many different variants of how conduction system pacing can be implemented are described in the literature. The large number of different variants cannot be mapped with InterSim. Therefore, the following variant was chosen, which can still be discussed:

- One atrial lead
- One (right ventricular) lead located in the left Tawara branch below the bundle of HIS
- Two shock coils: RVcoil and SVCcoil

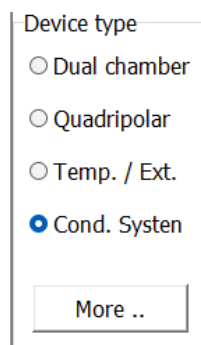
The simulation was based on the assumption that CSP is primarily used in conjunction with LBBB or AV-Block III.

Device Type

Conduction system pacing is selected via a new device type:



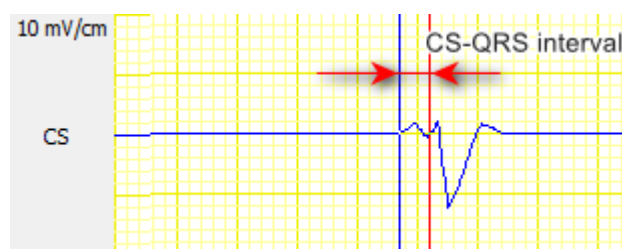
resp.



Parameters menu

CS-QRS interval

A new interval determines the distance between the CS signal and the far-field QRS complex.



The interval to be set can be found in the Parameters menu under the Intervals menu item.

Intervals

PR
Interval (ms) 170

RP
Interval (ms) 280

Block Rate
Rate (bpm) 171

Premature Contractions Coupling Interval
Interval (ms) 250

Vulnerable Phase
Interval (ms) 60

BBB QRS Width
Interval (ms) 180

CS-QRS Interval
Interval (ms) 25

Ok Cancel

Parameters

Intervals

PR
Interval (ms) 170

RP
Interval (ms) 280

Block Rate
Rate (bpm) 171

Prem. Coupl. Interval
Interval (ms) 250

Vulnerable Phase
Width (ms) 60

BBB QRS Width
Width (ms) 160

CS-QRS
Interval (ms) 25

Interface menu

The new CS signal can also be defined by amplitude and threshold voltage. The CSP Parameters dialog menu item is included in the interface menu for this purpose.

CSP Parameters - the dialog can be left open

Body Impedance
Impedance (Ohm) 35

Atrial Amplitude
Amplitude 2.5 mV

Atrial Threshold
Threshold (V) 1.0 V
at Pulse Width (ms) 0.40

Atrial Impedances
Tip Condition Normal
Tip Imp. (Ohm) 400
Ring Condition Normal
Ring Imp. (Ohm) 150

Atrial Resulting Impedances
Unipolar (Ohm) 435
Bipolar (Ohm) 550

Atrial EMI
☒ Off
☐ 50 Hz 5 mV
☐ 50 Hz 0.5 mV
☐ Artifacts
☐ Noise

CSP Amplitudes
P Wave 0 mV
Conduction System 1.0 mV
QRS 6.0 mV

CSP Impedances
Tip Condition Normal
Tip Imp. (Ohm) 380
Ring Condition Normal
Ring Imp. (Ohm) 150

Resulting CSP Impedances
Unipolar (Ohm) 415
Bipolar (Ohm) 530

CSP Threshold
Selective Threshold (V) 1.0 V
Non-Selective Threshold (V) 2.0 V
at Pulse Width (ms) 0.40

CSP EMI
☒ Off
☐ 50 Hz 5 mV
☐ 50 Hz 0.5 mV
☐ Artifacts
☐ Noise

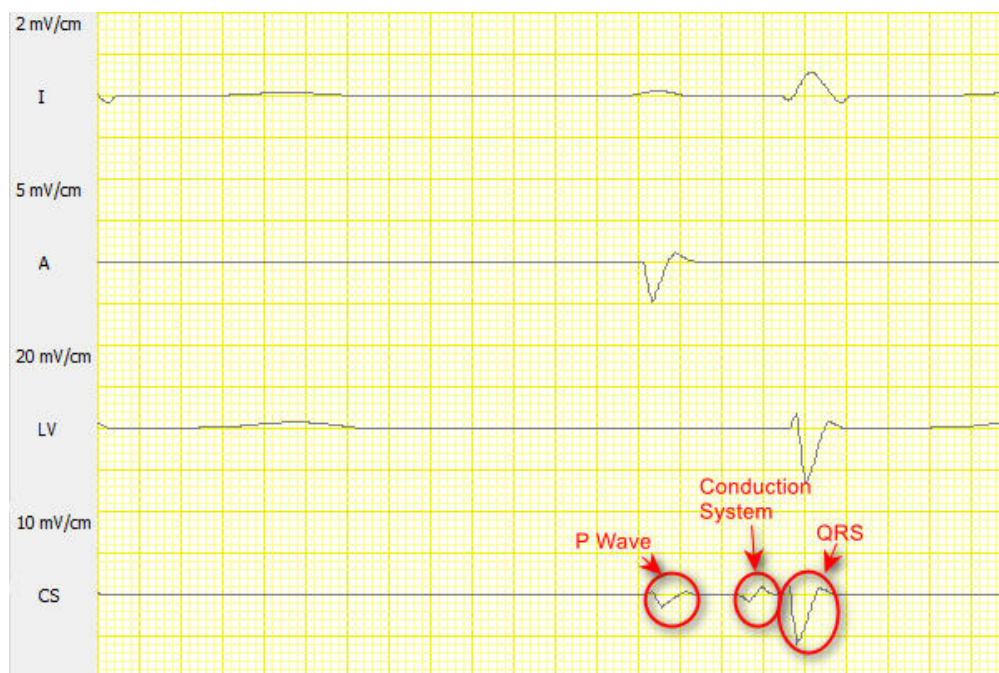
Refresh Apply Close

With the InterSim Touch, the entries under IF PM menu change:

File	Parameters	Oversensing	Rhythms	locks						
<table border="1"> <tr> <td>Amplitudes</td> <td> Atrial Amplitude Amplitude 2.5 mV </td> </tr> <tr> <td>Thresholds</td> <td> CSP Amplitudes P Wave 0 mV Conduction System 1.0 mV QRS 6.0 mV </td> </tr> <tr> <td>Impedances</td> <td></td> </tr> </table>					Amplitudes	Atrial Amplitude Amplitude 2.5 mV	Thresholds	CSP Amplitudes P Wave 0 mV Conduction System 1.0 mV QRS 6.0 mV	Impedances	
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Impedances										
<table border="1"> <tr> <td>Amplitudes</td> <td> Atrium Threshold 1.0 V Pulse Width 0.40 ms </td> </tr> <tr> <td>Thresholds</td> <td> CSP Selective Threshold 1.0 V Non-Sel. Threshold 2.0 V Pulse Width 0.40 ms </td> </tr> <tr> <td>Impedances</td> <td></td> </tr> </table>					Amplitudes	Atrium Threshold 1.0 V Pulse Width 0.40 ms	Thresholds	CSP Selective Threshold 1.0 V Non-Sel. Threshold 2.0 V Pulse Width 0.40 ms	Impedances	
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Impedances										

CSP-Amplitudes

Three different signals with different amplitudes can be generated on the CS lead: far-field P-Wave, Conduction System signal, far-field QRS complex



It can be a little confusing that the Conduction System signal is missing for LBBB without stimulation.

The amplitudes of the three signals can be set independently of each other.

CSP Amplitudes	
P Wave	1.5 mV
Conduction System	1.0 mV
QRS	6.0 mV

resp.

CSP Amplitudes

P Wave
1.5 mV

Conduction System
1.0 mV

QRS
6.0 mV

CSP Thresholds

There are two threshold values for CSP: one is for selective pacing, the other for non-selective pacing. The ECG changes during the transition from selective to non-selective pacing, see below.

CSP Threshold

Selective Threshold (V) 1.0 V

Non-Selective Threshold (V) 2.0 V

at Pulse Width (ms) 0.40

resp.

CSP

Selective Threshold
1.0 V

Non-Sel. Threshold
2.0 V

Pulse Width
0.40 ms

ECGs/EGMs

Selective Conduction System Pacing

Selective Threshold (1 V) < Pacing Amplitude (2 V) < Non-Selective Threshold (3 V)

InterSim settings

LBBB, PR=170ms

CS-QRS Interval=25 ms

V-Pace-Q-Latency=1ms

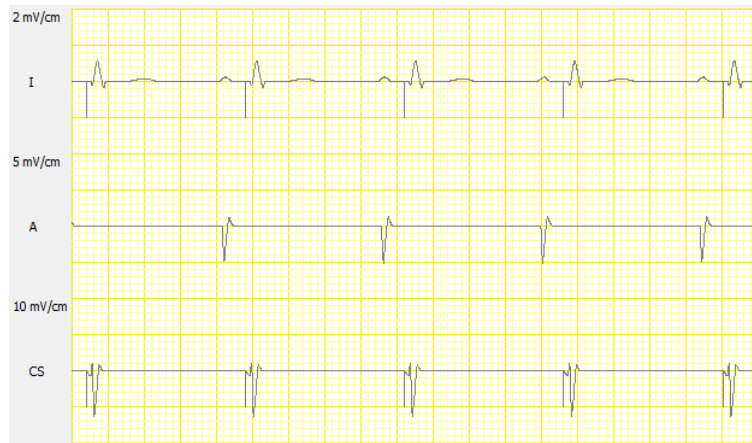
Selective Threshold=1 V

Non-Selective Threshold=3 V

Pacemaker Settings

Sensed AV=110 ms

Pacing Amplitude=2 V



Non-Selective Conduction System Pacing

Non-Selective Threshold (3 V) < Pacing Amplitude (4 V)

InterSim settings

LBBB, PR=170ms

CS-QRS Interval=25 ms

V-Pace-Q-Latency=1ms

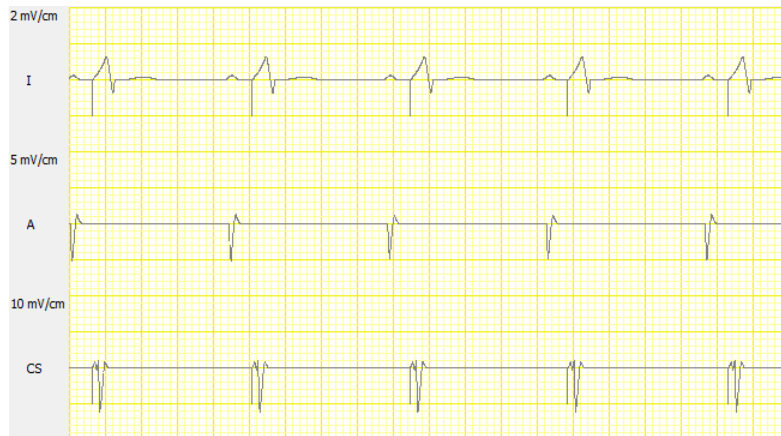
Selective Threshold=1 V

Non-Selective Threshold=3 V

Pacemaker settings

Sensed AV=110 ms

Pacing Amplitude=4 V



"Late" Conduction System Pacing 1

Intrinsic conduction to the RV is slightly faster than conduction from the CS pace to the LV

InterSim settings

LBBB, PR=170 ms

CS-QRS Interval=25 ms

V-Pace-Q-Latency=1ms

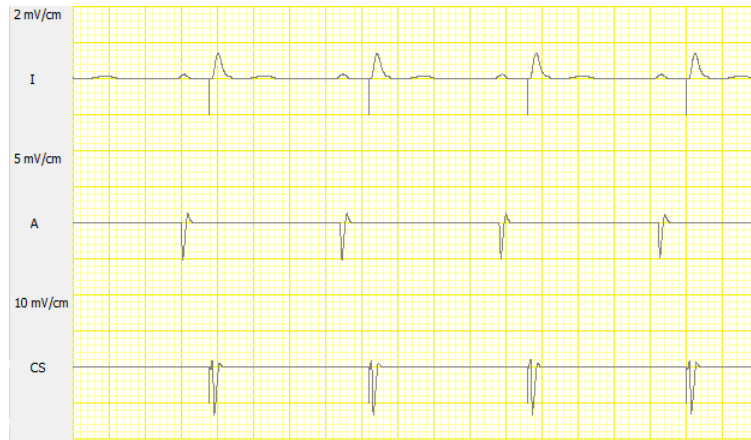
Selective Threshold=1 V

Non-Selective Threshold=3 V

Pacemaker settings

Sensed AV=130 ms - 140 ms

Pacing Amplitude=2 V



“Late” Conduction System Pacing 2

Intrinsic conduction covers both ventricles, normal LBBB ECG

InterSim settings

LBBB, PR=170ms

CS-QRS Interval=25 ms

V-Pace-Q-Latency=1ms

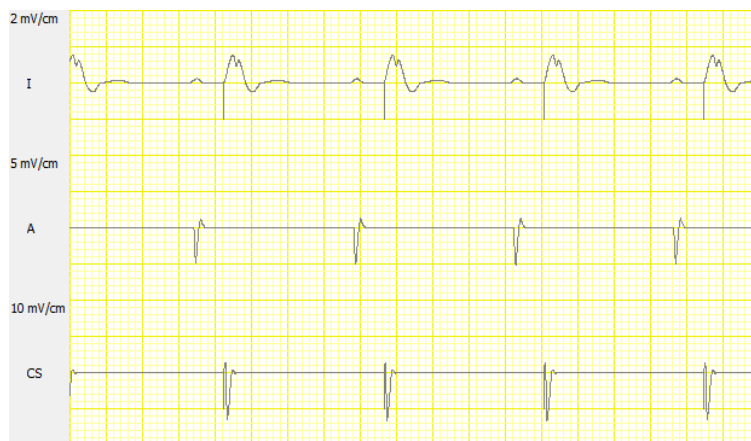
Selective Threshold=1 V

Non-Selective Threshold=3 V

Pacemaker settings

Sensed AV=160 ms and more

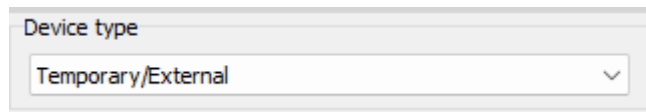
Pacing Amplitude=2 V



Temporary Pacemaker

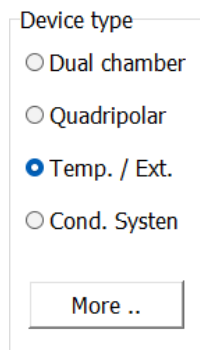
Device Type

Temporary/external pacemakers are now selected via a new device type:



A screenshot of a software interface showing a dropdown menu labeled 'Device type'. The menu is open, and the selected option is 'Temporary/External'.

resp.



A screenshot of a software interface showing four radio button options for 'Device type': 'Dual chamber', 'Quadripolar', 'Temp. / Ext.', and 'Cond. System'. The 'Temp. / Ext.' option is selected. Below the options is a button labeled 'More ..'.

Amplitudes

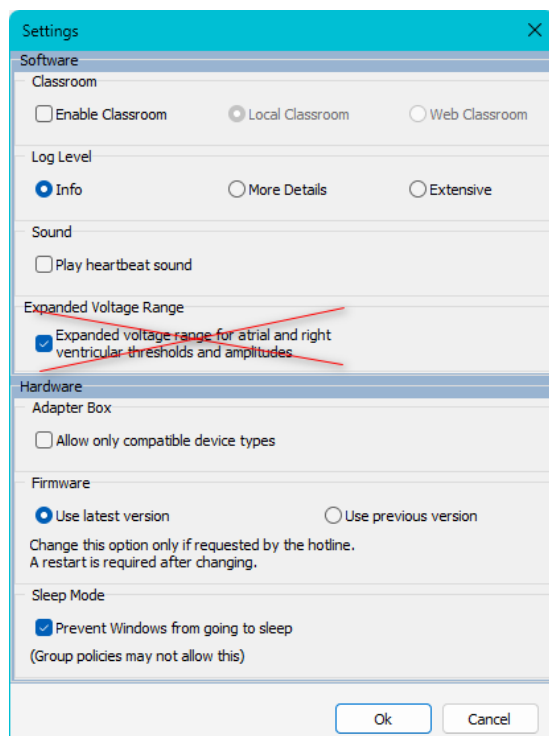
If the Temporary/External device type is selected, an enlarged amplitude range is available on both channels: 0,15mV - 25mV

Thresholds

If the Temporary/External device type is selected, an enlarged threshold range is available on both channels: 0,5V - 8V

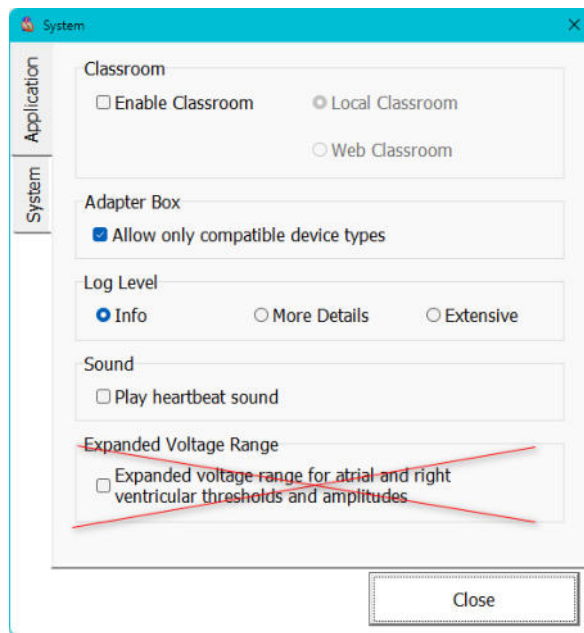
Expanded Voltage Range

The Expanded Voltage Range checkbox under File/Settings



A screenshot of a 'Settings' dialog box. The 'Software' section is expanded, showing options for 'Classroom' (Enable Classroom, Local Classroom, Web Classroom), 'Log Level' (Info, More Details, Extensive), and 'Sound' (Play heartbeat sound). The 'Expanded Voltage Range' section is also expanded, showing a checked checkbox for 'Expanded voltage range for atrial and right ventricular thresholds and amplitudes'. The 'Hardware' section is also expanded, showing options for 'Adapter Box' (Allow only compatible device types), 'Firmware' (Use latest version, Use previous version), and 'Sleep Mode' (Prevent Windows from going to sleep). The 'Ok' and 'Cancel' buttons are at the bottom.

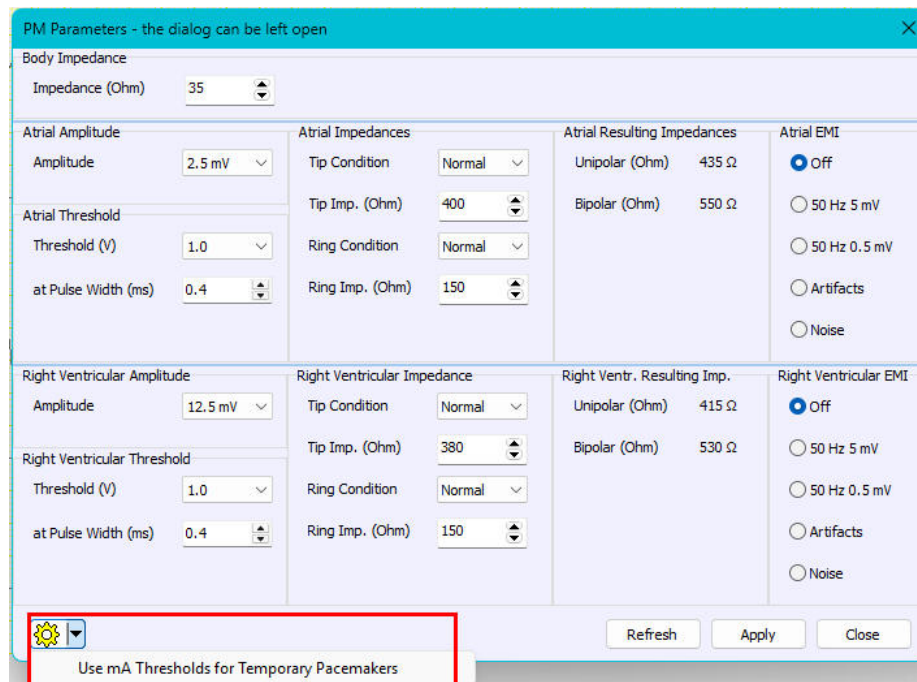
or File/System



has been removed.

mA Thresholds

For temporary/external pacemakers, you can switch to ma (milliampere) Thresholds.



resp.

File Parameters Oversensing Rhythms Blocks IF PM

Amplitudes Thresholds Impedances EMI

Atrium
Threshold
1.0 V
Pulse Width
0.4 ms

Right Ventricle
Threshold
1.0 V
Pulse Width
0.4 ms

Use mA Thresholds for Temporary Pacemakers

The possible range extends from 0.1 mA to 20 mA.

The measuring range of InterSim does not cover all combinations of impedance and current. The user is notified of the problem if the measuring range is exceeded:

Right Ventricular Amplitude
Amplitude
12.5 mV

Right Ventricular Impedance
Tip Condition
Normal
Tip Imp. (Ohm)
380
Ring Condition
Normal
Ring Imp. (Ohm)
150

Right Ventricular Threshold
Threshold (mA)
19.0
at Pulse Width (ms)
0.4

The combination of threshold and impedance exceeds the possible measuring range. Please reduce either the threshold value or impedance.

resp.

Amplitudes Thresholds Impedances EMI

Atrium
Threshold
19.0 mA
Pulse Width
0.4 ms

Right Ventricle
Threshold
10.0 mA
Pulse Width
0.4 ms

Use mA Thresholds for Temporary Pacemakers

The combination of threshold and impedance exceeds the possible measuring range. Please reduce either the threshold value or impedance.

Caution! The pulse widths of the external pacemakers differ significantly between the individual manufacturers. For this reason, the default pulse width of 0.4ms is used for all thresholds.

→ Use a state to save your special external pacemaker settings and load them again quickly.

Pacing spike output

The output pacing spikes on the surface ECGs have been enlarged.

Current of Injury

An injury potential can be output on the intracardiac electrodes A, RV, and CS.

Parameter

The Current of Injury potential is set via Parameters/Miscellaneous

Miscellaneous

A-Pace Crosstalk

☐ A-Pace Crosstalk

Latency (ms) 0

Width (ms) 80

A-Pace-P Latency

Latency (ms) 10

V-Pace-Q Latency

Latency (ms) 10

R Wave Variability with Respirational Cycle

Variability (%) 7

Special

☐ Early Recurrence of Atrial Fibrillation

☐ Early Recurrence of Ventricular Tachycardia

☐ Atrial Current of Injury

☐ Ventricular Current of Injury

☐ Conduction System Current of Injury

Ok Cancel

and for InterSim Touch also via Parameters/Miscellaneous.

Parameters

Oversensing

Rhythms

Blocks

IF PM

IF ICD

Macros

Intervals

Exercise

ATP

Induction

PVC Amplitudes

Miscellaneous

V-Pace-Q Latency

Latency (ms) 10

R Wave Var. w. Resp. Variability (%) 7

Special

☐ Early Recurrence of Atrial Fibr.

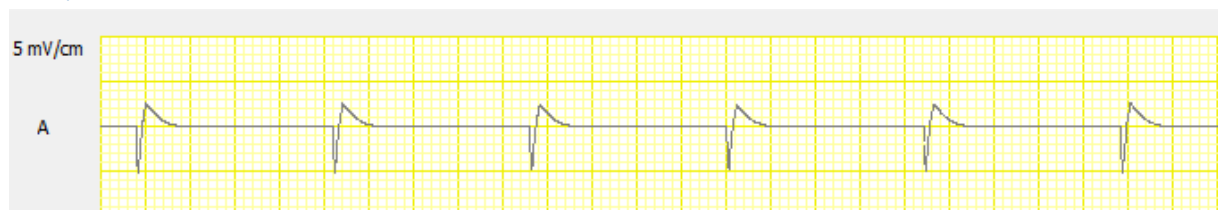
☐ Early Recurrence of Vent. Tachy

☐ Atrial Current of Injury

☐ Vent. Current of Injury

☐ CS Current of Injury

ECG/EGM





In the atrial, right ventricular or CS EGM, depending on which COI is selected, there is an elevation that decreases over time. COI switches off automatically after 5 minutes.

Miscellaneous

ATP (iATP)

With antitachycardic pacing, the conventional or a new behavior can be selected:

ATP and Induction

ATP Induction

Chances for ATP / %
(Ventricular Tachycardias, rate < 180 bpm)

Termination 100

Accel. 50 ms 0

Accel. 70 ms 0

Degeneration 0

No Response 0

New ATP response

☒ Use new ATP Response

Distance to RVT Circuit (ms) 100

Add 35 ms to the given value for LVT Circuit

Ok Cancel

resp.

File Parameters Oversensing Rhythms Blocks IF PM iCD

Rates Intervals Exercise ATP Induction PVC Amplitudes

Chances for ATP / %

Termination 100

Accel. 50 ms 0

Accel. 70 ms 0

Degeneration 0

No Response 0

New ATP Response

☒ Use new ATP Response

Distance to VT Circuit (ms) 100

As different distances to the VT circuit can be selected in the new procedure, it can be adapted more flexibly to individual requirements. The extra stimulus to terminate the tachycardia must hit the gap between 76% and 80% of the tachy interval.

AV Block III

Up to now, AV block III prevented both antegrade and retrograde conduction. With this version, conduction is only blocked antegrade as in InterSim II.

P Wave on RVRing (AVopt)

A Farfield P wave is output on RVRing. When using the RV standard amplitude of 12.5 mV, this is 0.6 mV. The width of the P wave is derived from the PR interval (PR - 60 ms).

Pulse Width

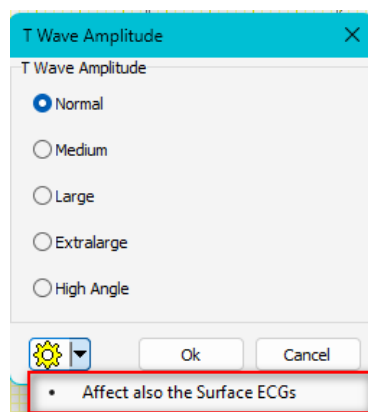
A pulse width can now be specified for all thresholds. This makes it easier to map the parameters of different pacemakers.

The internal calculation still follows a strength duration curve. A pace is effective if the following applies:

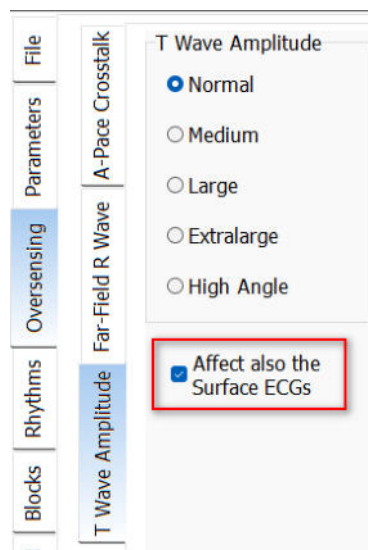
$$\text{Pace Pulse Voltage} > \frac{\text{Threshold set}}{2} * \left(1 + \frac{\text{Pulse Width set}}{\text{Pace Pulse Width}}\right)$$

T Wave Amplitude

Setting the T-wave amplitude now also influences the surface ECGs. The old behavior can be restored via a system setting in the T-Wave amplitude dialog.



Resp.



Ingenieurbüro Lang
Dipl.-Ing. Lutz Lang
Hintere Dorfstr. 10
09661 Rossau
Germany
Phone: +49 3727 649947
Mail: Lutz.Lang@Lang-IB.de
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