





1

A decorative graphic on the left side of the slide consisting of many thin, wavy, concentric lines that curve from the top left towards the bottom right.

## Objectives

At the end of this training, you will be able to:

- Identify pacing morphology for RV, LV, and BiV capture
- Recognize and program around anodal stimulation and diaphragm stimulation
- List the LV pacing vectors to program to avoid anodal stimulation
- List the LV pacing polarity options for HF-T ICD, QP device, and HF-T PPM

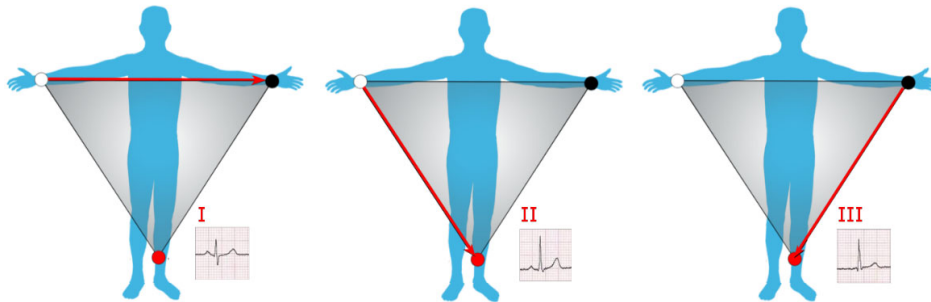
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## Einthoven's Triangle

Review Einthoven's Triangle. The wave of depolarization is positive when moving towards the + electrode.

- Lead I/Vector is positive or negative?
- Lead II/Vector is positive or negative?
- Lead III/Vector is positive or negative?



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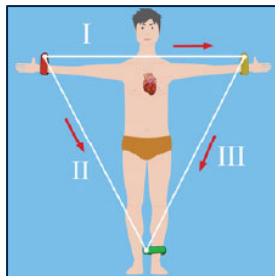
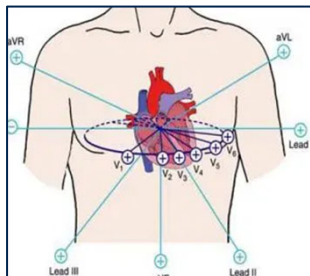
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## Einthoven's Triangle

Why is it important to have a surface ECG when performing threshold testing?

- IEGMs indicate if "capturing" but do not indicate "WHAT" is being captured
- Surface ECG:

1. RV only Lead 1/capture should be \_\_\_\_\_ morphology
2. LV only Lead 1/capture should be \_\_\_\_\_ morphology
3. BIV capture Lead 1/capture should be \_\_\_\_\_ morphology

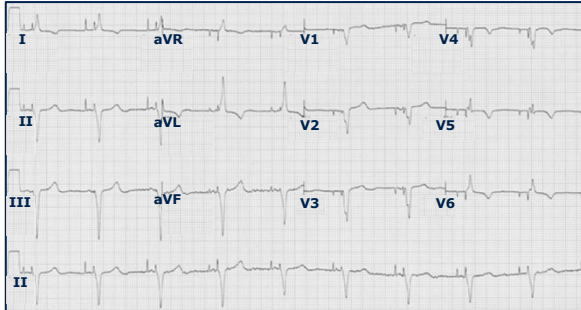
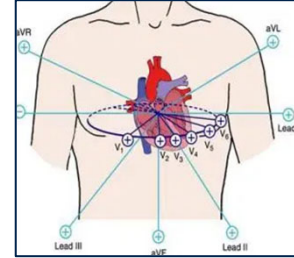


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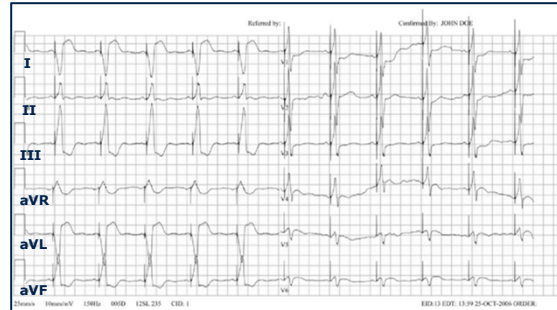
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## Practice Identifying Origin of Pace

Determine the origin of pacing from the ECG samples  
RV or LV only



**A**



**B**

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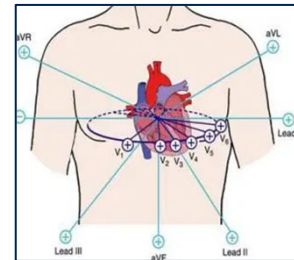
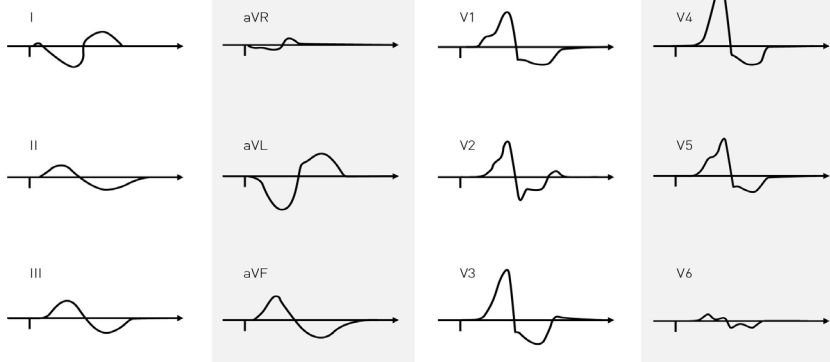
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## Practice Identifying Origin of Pace

ECG QRS patterns during LV pacing

Let's review:

Look at Lead 1 and V1:

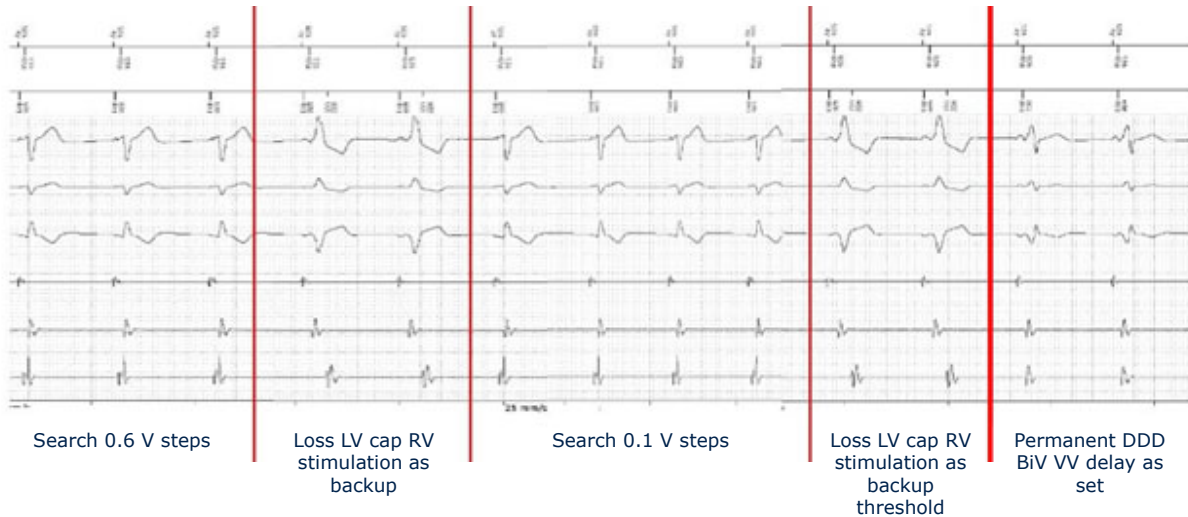


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## What Is Going On In This Example?



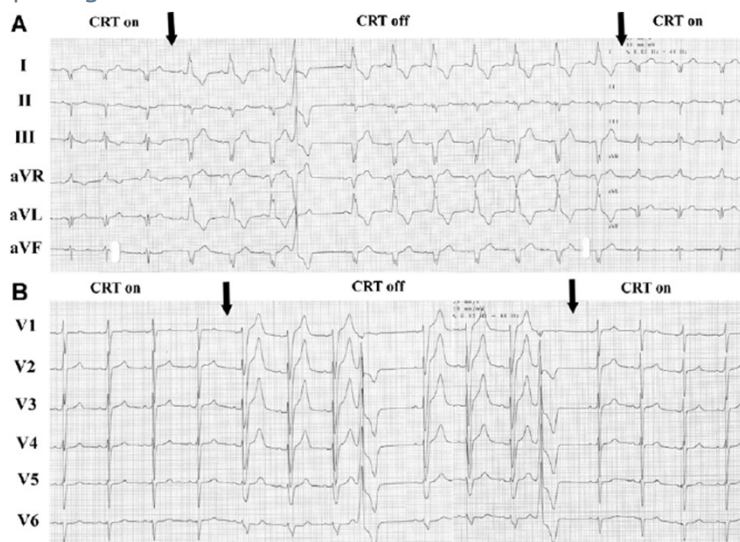
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## What Is The Morphology In Lead 1 And V1?

Is this RV or BIV pacing?



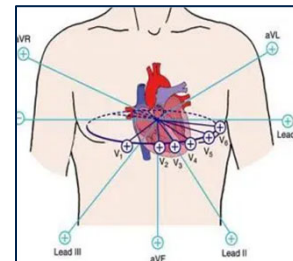
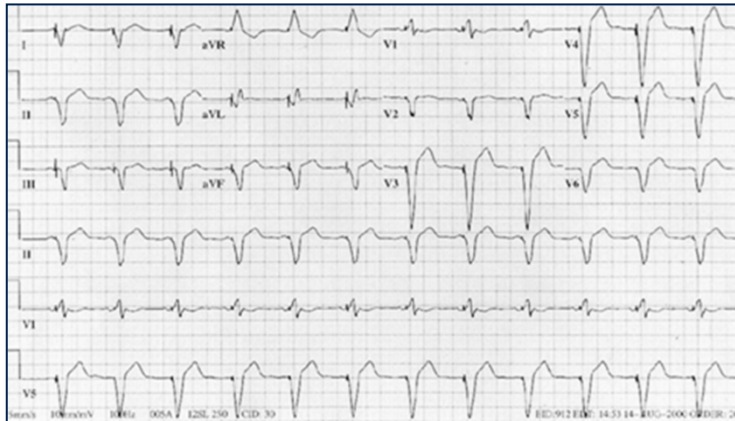
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## What Is The Morphology In Lead 1 and V1?

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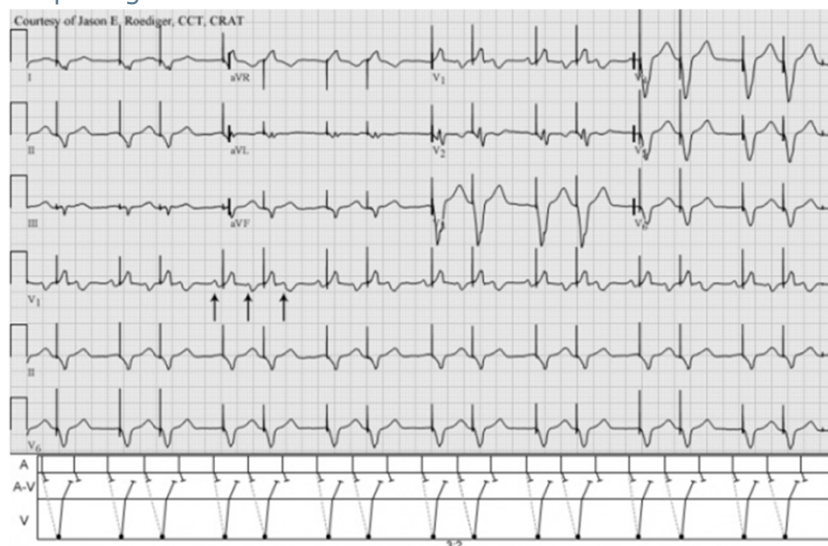
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## What Is The Morphology In Lead 1 and V1?

Is this RV or BIV pacing?



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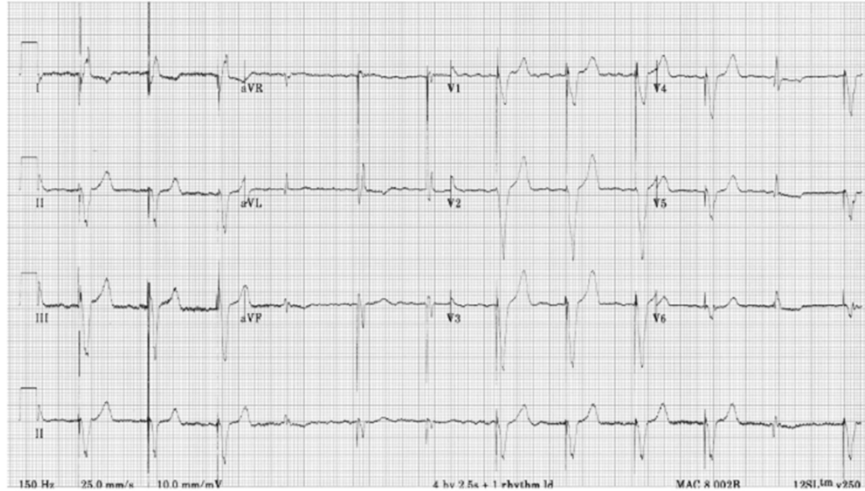
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## What Is The Morphology In Lead 1 and V1?

Is this RV or BIV pacing?



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## What Is The Morphology In Lead 1 and V1?

Is this RV or BIV pacing?



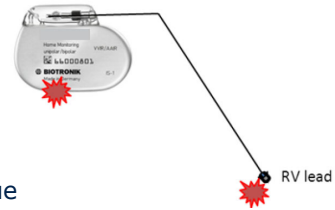
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## Considerations Regarding Anodal Stimulation

Review: What is anodal stimulation?

1. Ventricular pacing is usually accomplished by cathodal stimulation, in which the electrode functioning as the cathode depolarizes the muscle cells immediately adjacent to it, while the anodal electrode is passive regarding myocardial depolarization
2. Anodal stimulation: When cardiac pacing is performed in the bipolar configuration, both the cathode (negatively charged electrode) and the anode (positively charged electrode) are in contact with the myocardium
3. Current density: The definition, the amount of current flowing through a given cross-sectional area in a given time interval: usually measured in amperes per square meter/centimeter
4. Anodal stimulation = Anodal capture
5. Anode receives enough energy, then it can depolarize muscle tissue



Original example: unipolar pacing systems

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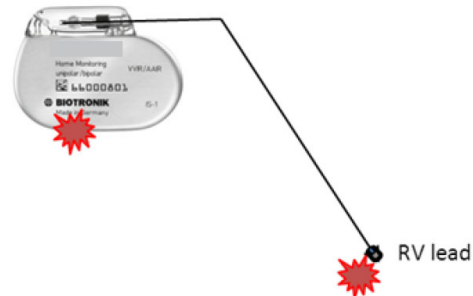
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## Considerations Regarding Anodal Stimulation

**Current density** if high enough, the muscle tissue beneath the anode will be depolarized (capture)

- "The anode becomes a virtual cathode"
- "Pocket stim" or "Pectoral muscle stim"



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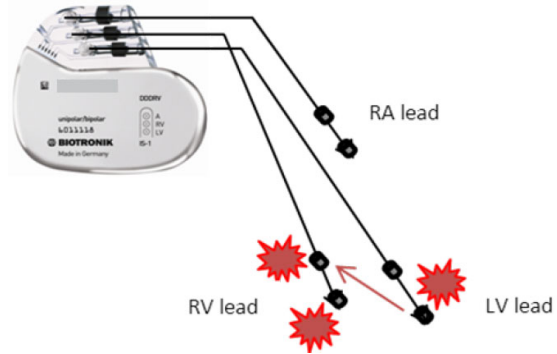
## Considerations Regarding Anodal Stimulation

### CRT's goal = 100% BiV pacing

Anodal stimulation = 'common ring' pacing

When sufficient energy is used, RV anode:

- Can act as a virtual cathode
- Becomes a third site of capture



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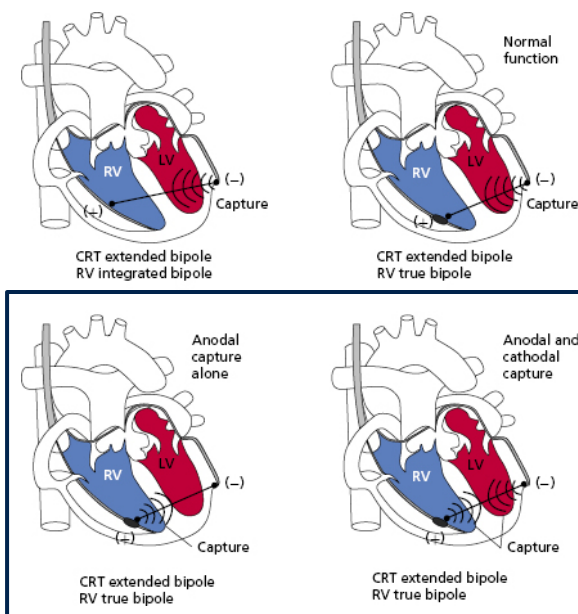
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## Anodal Stimulation

LV Pacing Polarities:

Which of these 4 configurations would you be concerned about Anodal stimulation?

The upper two figures demonstrate normal cathode capture. The lower left figure is pacing from the LV electrode without capture the LV instead its anodal stimulation of the RV ring electrode. The lower right shows capture of both the cathode (LV electrode) and anode (RV ring electrode).



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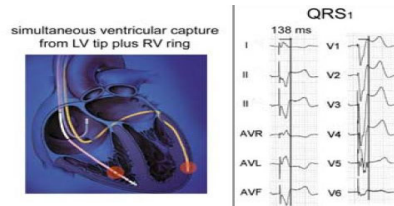
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## Anodal Stimulation

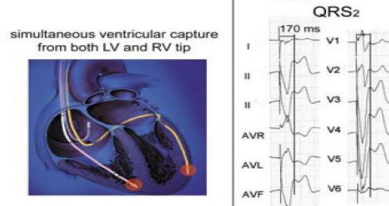
### QRS 1

- Anodal stimulation
- Positive complex in LL1 and negative in V1



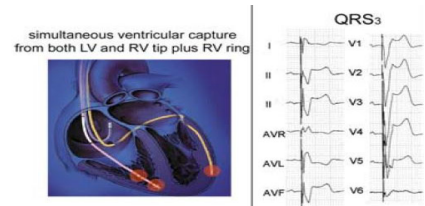
### QRS 2

- No anodal stimulation
- Negative in LL1 and positive in V1



### QRS 3

- Anodal stimulation
- Positive in LL1 and negative in V1



Anodal Capture in Cardiac Resynchronization Therapy Implications for Device Programming  
DAVID TAMBORERO,\* LLUIS MONT,\* ROBERTO ALANIS,\* ANTONIO BERRUEZO,\* JOSE MARIA TOLOSANA,\* MARTA SITGES,\*  
BARBARA VIDAL,\* and JOSEP BRUGADA\*  
From the \*Thorax Institute, Hospital Clínic, University of Barcelona, and Institut de Investigació en Biomèdica August Pi i Sunyer (IDIBAPS), Catalonia, Spain, and †Guidant Corporation Spain, Madrid, Spain.

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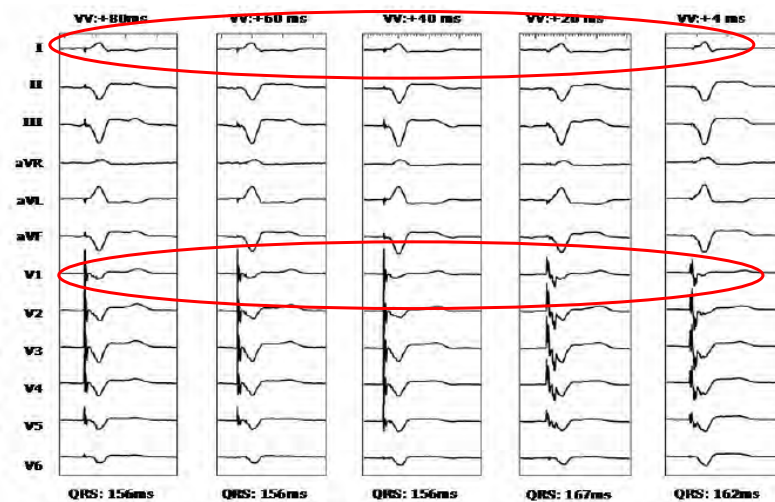
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## Anodal Stimulation

BiV pacing, LV first, configuration LVtip-RVring; RV+ capture

- What is the QRS morphology in LL1?
- What is the QRS morphology for V1?

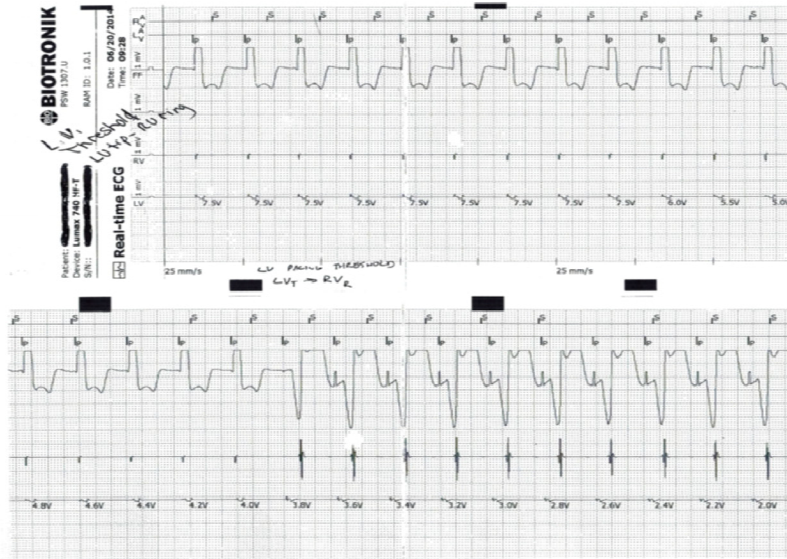


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## What Is Going On In This Example?



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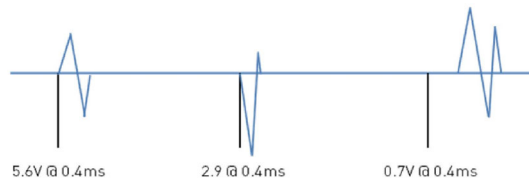
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## LV Pacing Only

1. Why are there three different pacing morphologies when doing an LV threshold test?

- First complex
- Second complex
- Third complex



2. When doing LV capture test and you see RV pacing morphology; consider anodal stimulation

3. What are your suggestions for troubleshooting and reprogramming when anodal stimulation occurs?

4. Anodal Stimulation Summary:

- Current density, if high enough; the muscle tissue beneath the anode will be stimulated
- BiV-Quick Fix: change LV vector (pacing polarity) to a non-RV anode configuration
- Why Worry:
  - a) During LV threshold testing the occurrence of anodal stimulation can lead to mistaken interpretation that the LV threshold is "high"
  - b) May not be receiving CRT

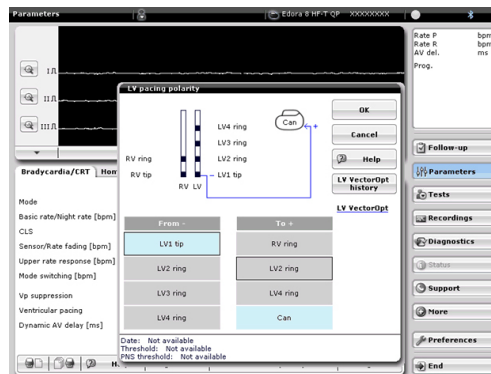
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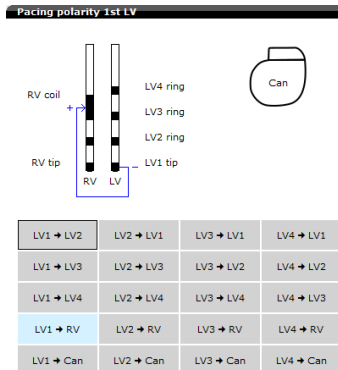
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## Practice Changing Vectors

- Practice changing the vectors on the programmer
- Remember, the best LV pacing vector is the vector with the lowest threshold without diaphragm stimulation
- Do not need to program a 2X safety margin for LV output



**Cor devices = 20 polarities**



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## Pacing Morphology/Vector Summary:

Origin	Quadrant	Lead I	Lead II	Lead III
Intrinsic	Normal	Positive Biphasic	Positive	Biphasic Positive
RV apical pacing	Left	Biphasic Positive	Negative	Biphasic Negative
RV septal pacing to RVOT	Right to Normal	Negative to Biphasic	Biphasic Negative to Positive	Biphasic to Positive
<b>LV only pacing</b>	Right	<b>Negative</b>	Biphasic Negative	Biphasic Negative
<b>Bi-V: (RV apex + LV)</b>	Extreme Right	<b>Negative</b>	Negative	Negative

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## CRT Morphology



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