



## **Field Uniformity and Electrode Sensitivity Considerations for Conductance Technology.**

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## The Scisense Advantage: “Tunable Segment” Technology

Conductance measurements are often used to derive physiological parameters. For purposes of this discussion, we will limit ourselves to multi-segment conductance catheters used to derive left ventricle blood volume. The two subjects that need to be understood are field uniformity and electrode sensitivity. One is a signal emitting concern and the second is a signal receiving concern. If ignored, the sum of the two can cause significant errors in the calculated data.

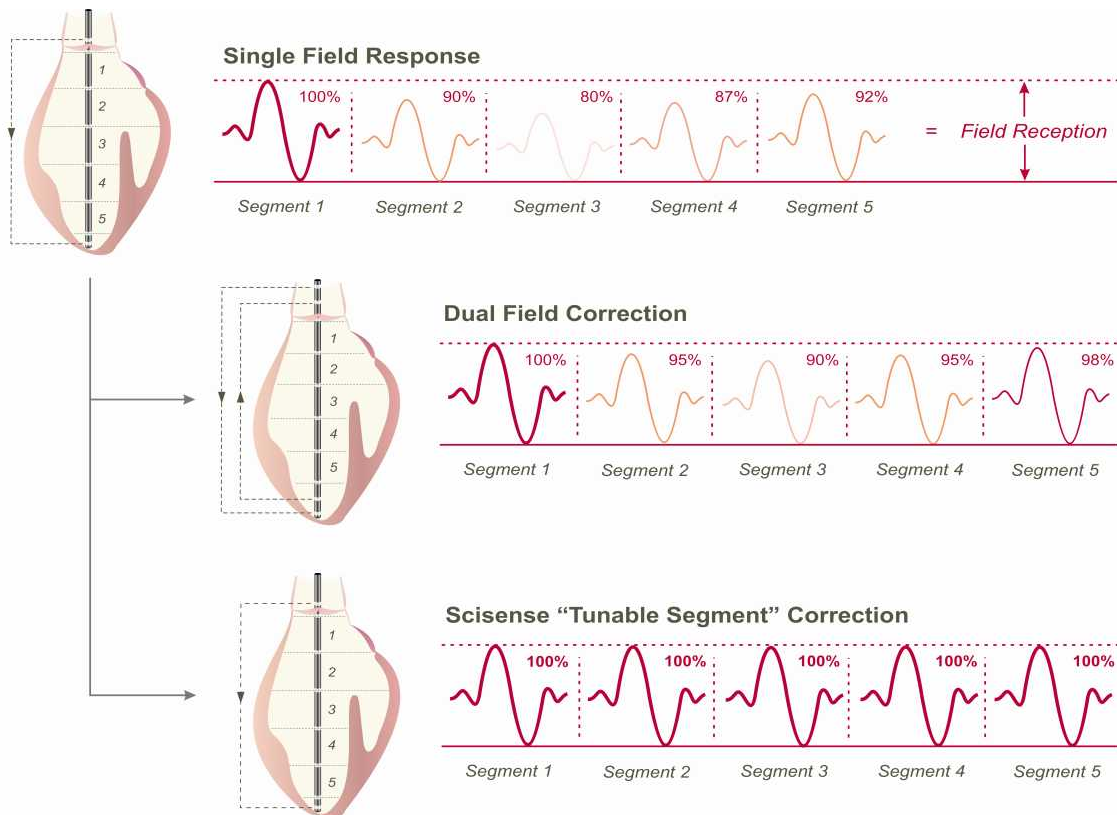
The conductance catheter sends a sinusoidal, constant current signal from a platinum electrode on one end of the catheter to a receiving electrode on the opposite end. This creates an electric field between the two electrodes. In between these electrodes, there are sensing electrodes used to detect the magnitude of the electric field within the blood. The sensing rings are arranged in pairs, and the voltage measured between any pair will depend on the magnitude of the electric field that they are exposed to. The more blood that is in the LV, the more field will be detected and the rings will read a lower voltage. The result is that each segment, or pair of sensing rings, will create a voltage that changes in proportion to the amount of blood during the heart cycle.

What must be appreciated is that the electric field is not of uniform shape. While not strictly true, let's envision the shape of the field as “pear” shape. This means that in a static situation, where the volume of blood is held fixed in a cylindrical well; the rings on one end of the array will see different field strength than the rings on the opposite end of the array. For a given field generated, the segments will report a different voltage even though all segments are exposed to the same segmental volume. If the voltages are to be summed in order to determine a total volume, the difference in outputs needs to be considered.

There are two ways to deal with field non-uniformity. Either make the field uniform, or compensate at the receiving electrodes. Attempts to make the field uniform typically involve adding a pair of transmit rings adjacent to the existing transmit electrodes. The new rings generate a field with opposite polarity so that the composite field has a more uniform distribution. This will improve the situation; however the new field will still have a less than perfect distribution: Picture the field as now having a “figure eight” shape. The dual field does not address the second issue of catheter sensitivity as regards the receiving rings.

An alternate method of field compensation is to assign individual gain control to each sensing pair. If we have all the rings exposed to the same fixed segmental volume, it becomes a simple exercise to add gain to the sensed signals such that they all report the same voltage.

An advantage of the segmental gain method is that it compensates for any variability of electrode sensitivity. The ability of the electrodes to sense the field is very dependent on how clean the rings are. If they are contaminated with tissue from a previous experiment or if there is any tarnish on the rings, they will read different values from experiment to experiment. By using segmental gain control, and adjusting the rings to read a given output for a given segmental volume, the researcher can deal with both field geometry and catheter sensitivity at the same time.



**Figure 1.0** – Depiction of Single Field non-uniform reception and two ways of correction;  
 1) Dual Field: the addition of a second electric field to force a more uniform overall electric field,  
 2) Scisense "Tunable Segment" gain correction method ensuring identical segmental field reception



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