The bioelectrical sources of the heart are distributed through the space of the myocardium or, in an approximate consideration of the depolarization process, over the surface of the excitation wave front. Thus, it is sometimes advantageous to use models or other equivalent generators of a distributed type for mathematical description of the cardiac electrical generator. They should be preferred in comparison with idealized point generators, the formulation and interpretation of which meets with known difficulties. So attention was recently paid to the theoretical possibility of representing the cardiac generator by current sources in the form of a double layer over a closed surface surrounding the heart (Geselowitz, 1976).

Let us suppose, that current sources are contained in a finite region of a homogeneous infinite volume conductor inside a closed surface S. Then it is possible to show that the potential outside the surface S is expressed as

$$\varphi = \frac{1}{4\pi} \int_S \varphi \cdot \text{grad} \left( \frac{1}{\varphi} \right) \cdot d\mathbf{S} \quad \text{(1)}$$

where \(\varphi\) is the distance from any point of the surface S to the point of measurement of the potential, \(d\mathbf{S}\) is the vectorial element of the surface S, and \(\varphi_s\) is the potential which would exist on the surface S if a dielectric medium was outside S, i.e. the potential would be generated by the same sources situated on the surface of a homogeneous finite volume conductor bounded by the surface S.

On the other hand, a current double layer with the surface dipole moment density \(\mathbf{j}\), distributed on a surface S in a homogeneous
infinite conductor with the resistivity $\epsilon$, outside the surface $S$ generates the potential

$$\varphi = \frac{\epsilon}{4\pi} \int_S \nabla \cdot \left( \frac{1}{r} \right) \cdot dS$$  \hspace{1cm} (2)

The comparison of the equations (1) and (2) shows, that if these two potentials are equal, i.e. the double layer is equivalent to the true sources, the following relation is valid:

$$J = \frac{\varphi S}{\epsilon} + J_0$$  \hspace{1cm} (3)

where $J_0$ is an arbitrarily chosen term which is constant over the whole surface $S$. This term characterizes the surface dipole moment density of a uniform closed double layer which does not generate potentials in the external region with respect to the surface $S$.

Using the foregoing double layer as a description of the cardiac generator the surface $S$ should be chosen as closely as possible to the true generators, so that the double layer most precisely reflects the structure of the true generator. For example, it may coincide with the epicardial surface of the heart ventricles or some other surfaces enveloping tightly enough the excitable muscle of the heart.

To define the function $J$ it is necessary to find the first term of the equation (3) namely

$$J_S = \frac{\varphi S}{\epsilon}$$

and to choose the value $J_0$. There are several approaches to determine $J_S$ from measurements of the potential on the body surface and of coordinates of this surface (solution of the so-called inverse problem). In this paper we will consider the possibility to determine the function $J_S$ approximately, using several initial members of a multipole expansion of the cardiac generator. Then it would be reasonable to choose such a value $J_0$ for each time instant that the function $J$ should be non-negative over the whole surface $S$. This means that the surface dipole moment density of the double layer would be directed from its internal to its external side in accordance with the predominantly radial direction of the propagation of excitation in the wall of the heart ventricles, as it is shown electrophysiologically.

Let the surface $S$ be a sphere with the radius $R$, fully including the heart ventricles. Then it is possible to show that the main part of the surface dipole moment density

$$J_S = \frac{\varphi S}{\epsilon}$$