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Means To Power In-Bore Electronic Devices From MRI System B_1 Fields

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The goal of this invention is to assist or replace the batteries or external power sources (AC or DC) normally used to power devices used in the magnetic resonance imaging (MRI) environment.

SPECIFICATION

Examples of devices used in MRI suites today include cardiac monitoring devices, electrocardiographic (ECG) gating devices, patient monitoring systems, patient notification and/or stimulation devices for functional imaging, and various other mechanisms. Devices such as these are typically powered by an internal battery. The disadvantage an internal battery poses is that it must be recharged or replaced on a frequent basis. This invention will either replace the internal battery completely or it may be used to maintain the charge on an internal battery without the need for an external power source to recharge it. The invention obtains its power from the dynamically changing (i.e., B_1) radio frequency (RF) and/or gradient fields created within the bore of an MRI scanner as part of the imaging process. Significantly, the invention is designed so that it will distort neither the RF B_1 field nor the gradient B_1 field in an observably detrimental way.

The invention consists of one or more inductive pickup coil(s) that are exposed to the RF and gradient B_1 fields generated by an MRI system, and/or to the audio frequency gradient waveforms in the bore of the scanner. Because the RF and gradient fields both change with time, a coil placed within or near the bore will produce an AC voltage due to and proportional to the changing B_1 fields to which it is exposed. The RF pulses in an MRI system will have a frequency proportional to the static (B_0) magnetic field of the MRI system; for systems providing images or spectra from hydrogen, the frequency is nominally $42.58 \text{ MHz} \times B_0$ in Tesla. The RF B_1 field is typically circularly polarized, and normal to the axis connecting the north and south poles of the B_0 magnetic field. The gradient B_1 fields will have an audio frequency component in the range of 1 Hz to 100 kHz, and will typically exist in all three planes, X, Y, and Z.

In the preferred embodiment, the invention consists of a pickup coil system that is designed to intercept either the RF B_1 field from the body coil of the MRI scanner (or a separate transmit coil) or the gradient B_1 fields in any or all of the three principle planes, or both. The AC signals acquired by the pickup coil(s) are delivered to a rectifier device suitable for the frequency and amplitudes involved, and the harvested DC power is delivered to a power management block that will store the harvested DC power in a local battery or storage capacitor. The battery or storage capacitor will provide power for the device to be used. A regulated switching power supply or other efficient power conversion and conditioning system will provide efficient adaptation of the available power to the application. If needed, a port will be provided to allow an initial supply of power to be inputted to the device when there has not been sufficient power harvested from the B_1 field interception of the invention. To minimize the effect on the homogeneity of the RF B_1 field

in terms of the impact on imaging experiments and procedures, the invention may use more than one pickup coil, with the elements of the pickup coil system so arranged as to extract the power from the field within the volume of the pickup coil(s), while minimizing the impact on the field pattern outside of the volume.

