12.16 NEW PROCEDURES FOR THE DESIGN OF IMPLANTABLE PASSIVE TELEMETRY SYSTEMS

Ostgen, M., Nagel, J., Schaldach, M.

Zentralinstitut für Biomedizinische Technik der Universität Erlangen-Nürnberg (Germany)

For both control of medical implants like pacemakers or drug-infusion-systems and surveillance of patients, a continuous data-flow of biomedical and physiological signals and functional parameters is required from the implanted devices. Wireless telemetry systems for the informationtransfer do not involve the risk of an infection and render the patient to be free movable.

Simple inductive telemetry systems are best suited for this application, using the electromagnetic coupling of two transmission-coils for the signal-transmission. However common inductive telemetry systems supply their power-consumption from the implanted battery, shortening the life-time of the implant essentially.

Avoiding both life-time reduction and problems resulting from an inductive energy-transmission into the implant, a passive telemetry system has been developed showing good transmission-characteristics including practically no power-consumption from the implanted battery. Its application in medical implants enables a long-time-surveillance without effecting the implants life-time.

The function of the passive telemetry system is based on impedance-changes of an implanted secondary LC-circuit which is stimulated inductively by an extracorporal oscillator. This stimulating signal has the function of a carrier for the information-transmission altered by the signal to be transmitted.

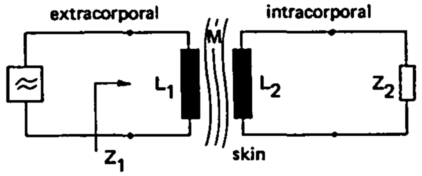

Fig. 1 Inductive transmitter with self-inductivities L_1, L_2 and mutual inductivity M

Depending on the special realization of the system the signal is available in the external circuit as either an amplitude- or frequency-modulated carrier-signal. Using a Fet as a secondary load resistance, altered proportional to the signal by its gate voltage, the necessary modulation power, supplied by the implanted battery, is neglectable.

In order to achieve a high efficiency, amplitude-modulated systems should show high signal depending changes of the resistive part of the input-impedance Z_1, given by (fig. 1)

$$Z_1 = j\omega L_1 + \frac{(\omega M)^2}{Z_2 + j\omega L_2}$$

Frequency-modulated systems are realized if the oscillator-frequency is determined by the impedance Z_1 of the transmitter: changes of the reactive part of the impedance Z_1 will cause frequency-shifts in the external circuit.

The analysis of the input-impedance Z_1 of the transmitter in fig. 1 in dependance of the complex load-resistance Z_2 shows that optimal transmission-characteristics can be achied only using AM-systems. In contrary to AM-systems FM-systems demand high inductivities for the implanted coil. It should also be mentioned that FM-telemetry-systems, based on electromagnetic coupling of two coils, do not offer the usual FM-advantage of lower sensitivity for interferences. Alltogether in this application the AM-system must be prefered definitly.

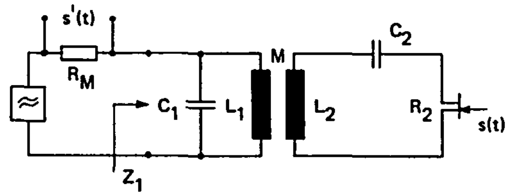

Fig. 2 Passive telemetry system with primary parallel and secondary serial-resonance

Different combinations of external and implanted resonance-circuits are possible to realize an AM-system. Primary parallel- and secondary serial-resonance, as shown in fig. 2, yields optimal transmission-characteristics.

In this case the input-impedance Z_1, given by

$$Z_1 = \frac{1}{j\omega C_1} + \left(\frac{L_1}{M}\right)^2 R_2$$

offers the optimal transmission-factor $(L_1/M)^2$. Secondary impedance-changes will be transmitted to the primary circuit with high efficiency, the desired signal can be monitored extracorporally without a remarkable power-consumption for the implanted battery.

Reference:

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