Antenna Design for Implantable Medical Device Communication in HF Band

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Recently, body implant systems for wireless communication devices have been developed for patient monitoring, diagnosis, and treatment. The transmitting antenna inside the body and the receiving antenna attached to the body surface are indispensable devices for real-time data transmission. The implantable medical device often uses the Medical Implant Communication Systems (MICS) band (402 - 405 MHz) for data transmission. However, electromagnetic waves decrease greatly with increasing frequency in the human body with high conductivity. The measured results in [1] show that the path loss of the 2.4 GHz communication system is about 80 dB with the antenna distance of 50 mm. Operation at lower frequencies can communicate with lower signal attenuation. In [2], the path loss is only about 40 dB at 30 MHz with the antenna distance of 50 mm. J. Wang, *et al*. developed a 10 - 60 MHz impulse radio (IR) based transceiver with corresponding antennas for human body communication [2]. Therefore, the resonant frequency of the proposed antennas is around 55 MHz. In this frequency band, The smaller the antenna, the narrower the bandwidth, so in such cases magnetic sheet may expand the bandwidth.

In this paper, we propose a coil antenna for implantable medical device communication. Detailed structure of the proposed coil antenna is shown in Fig. 1. The coil antenna consists of two coil elements (width = 0.3 mm, pitch = 0.5 mm) and a matching circuit. The two coil elements and matching circuit are each built on a flexible substrate and a magnetic sheet (ε_r = 80, tan δ_ε = 0.5, μ_r = 30, tan δ_μ = 0.35) is inserted between them. The magnetic sheet is 19 mm diameter and 0.3 mm thick. It is possible to expand the band by using two coils and bringing the resonance frequencies close to each other. Matching circuits are used to adjust the resonant frequency and for antenna miniaturization. Magnetic sheet can be used for coil antenna to satisfy bandwidth and increase channel capacity. Different layers are connected by via holes.

As a results of measuring S_{11} of the coil antenna, the total -10 dB bandwidth achieved 6.5 MHz. For future works, developing a receiving antenna to be installed outside the human body and evaluating channel capacity and bit error rate.

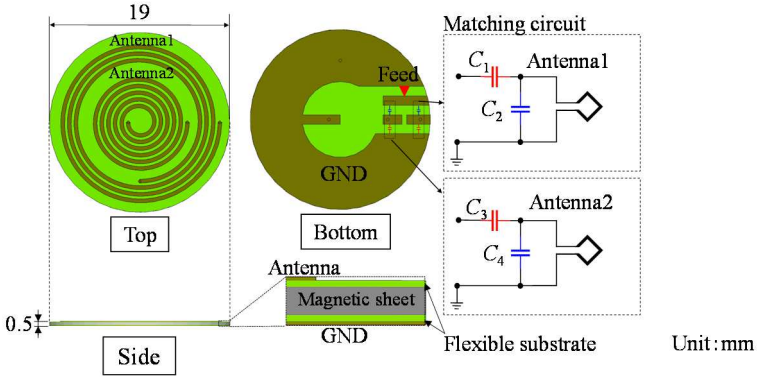

Figure 1. Coil antenna structure

References

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[2] J. Wang, J. Liu, K. Suguri, D. Anzai, "An in-body impulse radio transceiver with implant antenna miniaturization at 30 MHz," IEEE Microw. Wireless Compon. Lett., vol. 25, no. 7, pp. 484–486, July 2015.