

Using Superparamagnetic Nanoparticles To Open Doors

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1. Introduction

Optical coherence tomography is a rapidly emerging imaging modality demonstrating improved resolution over competing techniques such as magnetic resonance imaging (MRI), multi-sliced computed tomography, and ultrasound. The use of superparamagnetic iron oxide nanoparticles as a tissue specific contrast agent provides a wide variety of potential applications in biology and medicine.

2. Procedure

The generator itself was created in a very simple manner using a simple circuit consisting of 3 capacitors, 2 resistors, a IRFP460 MOSFET transistor, and a RUBP320 diode. Experiments conducted contrasted theoretical voltage outputs from the magnetic field generator with the actual voltages measured with an Agilent 4263B LCR Meter.

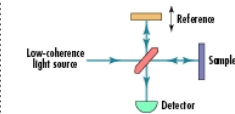
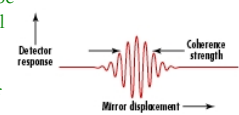
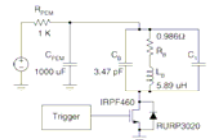


Figure 1. A depiction of how DP-OCT utilizes a single light source which is reflected by a tissue sample and a reference mirror to pinpoint the location of specific particles.

Figure 2. The mirror displacement that results can be attributed to a quasi-sinusoidal motion from the light source which is steadily fluctuated to encompass a broader range of frequencies.



3. Methods



The amplifier designed for the magnetic sensor is expected to have a cut-off frequency near 250 kHz, calculated considering the bandwidth of the operational amplifiers. This method was developed to generate magnetic fields at the frequencies needed to validate this theoretical finding. The excitation device is based on a resonant circuit built with a capacitor and the inductance of the coil.

4. Results

The frequency response of the magnetic sensor under test is expected to be flat until the first pole frequency at about 250 kHz. Different auxiliary parallel capacitors were used. In the case of 65.6 kHz, it was 1, for 104.2 kHz was 390 nF, 207.4 kHz corresponds to 100 nF and for 655.7 kHz the capacitor was 10 nF.

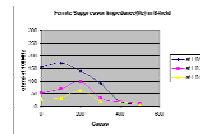


Figure 3. Current flowing through the coil in the magnetic field generator.

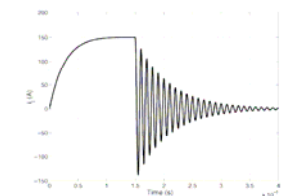


Figure 4. Usage of differing capacitors to achieve certain frequencies.

C_1	f_1 (kHz)	f_{max} (kHz)
1 μ F	65.6	64.2
390 nF	105	104.2
100 nF	207.4	206.9
39 nF	332.1	331.8
22 nF	442.1	441.9
10 nF	655.7	655.5

5. Conclusion

The use of a high-power voltage source has been avoided, yet full efficiency of magnetic pulses has been accomplished. The main advantages of the device are those that make the design extremely simple and inexpensive and present a versatile method to produce high-frequency quasi-sinusoidal magnetic field oscillations confined in a small region of space.



6. References

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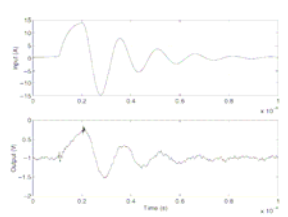


Figure 5. Excitation and measurement of the magnetic field created by the coil at 64.2 kHz. The two charts indicate first, the input values and the current indicates that as a function of time, the ampere stabilizes proportionally to the voltage output of the generated field.