[0005] Cancellation methods can be introduced to limit environmental interference passive reflections from environmental interference. Cancellation methods send a passive pulse to "learn" the reflective environment and then sends a calibrated active pulse to determine the modulation due to the implant. Using the difference of these two reflections helps to limit effects of environmental structures that may also reflect the ultrasound waves causing passive reflections. Although this limits issues due to passive reflections, these cancellation methods do not account for environmental interferences and changes that occur after the training pulses during the actual data transfers.

[0006] Therefore, challenges remain in overcoming passive reflections during ultrasonic backscatter communication between an interrogator and an implantable device.

SUMMARY

[0006a] In an aspect, the present disclosure refers to a method for communicating using ultrasonic waves comprising:

receiving, at one or more ultrasonic transducers of an implantable device, ultrasonic waves transmitted by an interrogator; and

emitting, from the one or more ultrasonic transducers of the implantable device, ultrasonic backscatter comprising encoded data, wherein the data is encoded into the ultrasonic backscatter by modulating a frequency of the ultrasonic backscatter.

[0006b] In an aspect, the present disclosure refers to a device for communicating via ultrasonic waves, comprising:

an ultrasonic transducer configured to receive ultrasonic waves and emit ultrasonic backscatter;

a switch configured to modulate a frequency of the emitted ultrasonic backscatter; and

a circuit configured to operate the switch to encode data in the emitted ultrasonic backscatter based on the frequency.

[0006c] In an aspect, the present disclosure refers to a system for communicating via ultrasonic waves, comprising:

the device of the above aspect; and

an interrogator comprising:

one or more ultrasonic transducers configured to receive the emitted ultrasonic backscatter and transmit the ultrasonic waves to the device; and

a processor configured to decode the emitted ultrasonic backscatter.

[0007] Amplitude modulation can be used to encode data into the ultrasonic backscatter for sending information from the implantable device to an external device. However, as described in the previous section, communication based on amplitude modulation is subject to noise from passive reflections and other sources of reflective interference which can negatively affect communication. Thus, there remains a need for encoding data into the ultrasonic backscatter to enable low-power and low-noise communication between the implantable device and the interrogator.

[0008] Methods and systems for low-power communication using ultrasonic waves are described herein. The methods may include receiving, at one or more ultrasonic transducers of an implantable device, ultrasonic waves transmitted by an interrogator; and emitting, from the one or more ultrasonic transducers of the implantable device, ultrasonic backscatter comprising encoded data, wherein the data is encoded into the ultrasonic backscatter by modulating a frequency of the ultrasonic backscatter. The device may include an ultrasonic transducer configured to receive ultrasonic waves and emit ultrasonic backscatter; a switch configured to modulate a frequency of the emitted ultrasonic backscatter; and a circuit (which is optionally an integrated circuit) configured to operate the switch to encode data in the emitted ultrasonic backscatter based on the frequency.