CHARACTERIZATION OF SYSTEM PROPERTIES FOR ULTRASONIC COMMUNICATION OF DIGITAL DATA THROUGH A SOLID WALL CHANNEL

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ABSTRACT

This thesis presents a method for characterizing a channel in an ultrasonic through-wall communication system. Several properties, including transducer impedance, power applied, power delivered, power transfer efficiency, and change in applied voltage, are determined over a frequency range containing the piezoelectric transducer frequency of resonance. Some properties, including power applied, power delivered, and power transfer efficiency are also found as a function of inside load resistance. At frequencies on the order of 1 MHz, coaxial cables and data acquisition devices exhibit significant capacitance that must be accounted for to obtain accurate impedance measurements. This thesis describes a calibration procedure to account for such capacitance. Two signal processing techniques, i.e., non-coherent and coherent demodulation, are employed and the results are compared. Solid wall channels using test blocks and transducers of various materials, dimensions, electrode configurations, and mounting methods are characterized and the results are presented and analyzed. It is observed that through-wall channels are frequency selective, and only certain frequencies yield large change in envelope and large power transfer efficiency, which are necessary for reliable communication and adequate power harvesting, respectively. In all cases, it is observed that the change in envelope peaks occur at frequencies where peaks in power transfer efficiency are observed. Thus, a carrier frequency that yields reliable communication is also effective for power harvesting. Using this result, an automated frequency selection algorithm is developed for future implementation in the Digital Signal Processor (DSP). The frequency selection routine is described in detail.