

MEASURING THE DIELECTRIC PROPERTIES OF A CONCRETE WALL USING AN ULTRA-WIDEBAND, TIME-DOMAIN MEASUREMENT SYSTEM

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The National Institute of Standards and Technology designed a new measurement system for determining the permittivity and loss tangent of a large concrete wall. This report will discuss the measurement system, the digital signal processing technique, the genetic algorithm, and the results of our measurements. These results will then be used in a database of other building materials in order to accurately simulate business or residential environments. The concrete walls were designed according to current building code specifications and include 1) a concrete wall without rebar, 2) a concrete wall with rebar, and 3) a rebar mesh as would be found in the previous concrete wall. This technique was developed to provide a portable system capable of measurements in an in-situ environment, such as the inner wall of a residential or office building. Currently, a modified form of the system is used to measure the shielding effectiveness of aircraft and is also used to measure targets in a cluttered environment. The system is an ultra-wideband, time domain measurement system using transmitting and receiving TEM half-horn antennas, a vector network analyzer, and a portable ground plane. The portability of this system allows us to move from our laboratory to other locations. Digital signal processing and the unique design of our TEM half-horn antennas allow us to isolate the sample from the rest of the measurement environment, thus simulating a measurement in free-space. The free-space transmission and reflection coefficients are used to extract the permittivity and loss tangent of the concrete wall using digital signal processing and a genetic algorithm optimization.

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