Antenna Impedance Extraction Technique Based on Far-field Measurement

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Antenna impedance is one of the fundamental parameters of antenna engineering. It is basically the key to design matching network in order to achieve optimal power transfer to the antenna. However, small wireless devices such as hearing instruments (HI) are difficult to measure antenna impedance directly with a vector network analyzer (VNA), due to the strong feed cable interaction with the electrically small antenna. Although baluns and ferrite beads are widely used to mitigate/eliminate the unwanted cable effects, complex housing configuration in a hearing instrument causes the antenna feed point hard to access. Additionally, the inconsistent device placement relative to a head and ears makes those coaxial cable add-on options not reliable and convenient to be used for HI or any other small wearable devices.

In this work, a novel impedance extraction technique based on far-field measurement is presented. The method was derived in theory and demonstrated using conductive and Over the Air (OTA) setups. The method requires multiple relative conductive/radiative power measurements out of the device under test (DUT). This DUT can be an antenna attached to different known matching networks to collect those multiple measurements. The Smith chart is then used to visualize the power ratio derived equations as arcs. The antenna input impedance can be extracted out of the arcs' intersections.

The technique is first applied within a conductive test environment to assess the performance of the proposed method. Using RF evaluation boards, excellent agreement was obtained from the extracted data using the method and traditional impedance measurements via VNA. Then the method was applied to an antenna within an in-situ hearing aid device in radiative environment to demonstrate its capability. The extraction yielded an accurate antenna impedance value, leading to an optimal matching network design for power transfer.

The proposed technique provides an innovative, accurate, and reliable technique for antenna engineers to tackle the matching problem especially for small antennas within a very complex in-situ environment. More details about the technique as well as other experiment results will be shown during the conference's presentation.