A Remote Radiation Pattern Measurement Technique for Electrically Small Antennas

Majid Manteghi, *Senior Member*, *IEEE*
Virginia Polytechnic Institute and State University, Blacksburg, VA
manteghi@vt.edu

Electrically small antennas, ESAs, are the common denominator of all small transceivers including internet of things, sensor nodes, implanted devices and so on. Most of these small transceivers are standalone devices and there is no cable attached to them. Therefore, the overall dimensions of the entire transceiver are usually fractions of the wavelength. In contrast, to measure the radiation pattern, one needs to connect the ESA to an instrument through a cable which makes the entire system much larger than the original device. Therefore, the measured radiation pattern does not necessarily represent the pattern of the standalone ESA. This presentation introduces a remote antenna measurement technique to evaluate the radiation pattern (more specifically co-pol. and cross-pol.) of an ESA without connecting it to an instrument.

In general, the radiation pattern of an ESA could be the result of radiating TE_{10} or TM_{10} or a combination of these two spherical modes. Therefore, the radiation pattern of a magnetic dipole, TE_{10}, and an electric dipole, TM_{10}, have a donut shape and the radiation null of the antenna reveals the entire radiation pattern. The uncertainty occurs when both modes are excited with unknown coefficients and one needs to measure the co-pol. and cross-pol. patterns.

This work uses a small low frequency battery operated oscillator connected to a diode (as mixer) at the antenna port. The entire circuitry can be packaged slightly larger than the coin battery and it wont effectively disturb the radiation pattern of antennas larger than a coin battery. A transmit antenna illuminates the AUT with a CW at the resonant frequency of the AUT. The received signal by the AUT is mixed with the low frequency oscillator and reradiates back to the transmit antenna. One can measure the power of the offset frequency using a spectrum analyzer connected to the transmit antenna through a directional coupler. The radiation pattern can be measured by rotating the AUT and assigning the square root of the received power to its associated angle of AUT.