Total Radiated Power: A Primer

Total Radiated Power (TRP) is a radio frequency (RF) engineering term used to describe the sum of all power radiated by an antenna connected to a transmitter. Total Radiated Power is closely related to the efficiency of the antenna, and is in fact tied to the definition of efficiency. In Figure 1 below, TRP is the Output Power, or P_{out}. Antenna efficiency, $\eta_{antenna}$, is the ratio of output power to input power. TRP is expressed in terms of power: Watts (W), milliwatts (mW), or the logarithmic terms for W and mW (dBW and dBm). Antenna efficiency is expressed either in percentage or dB.

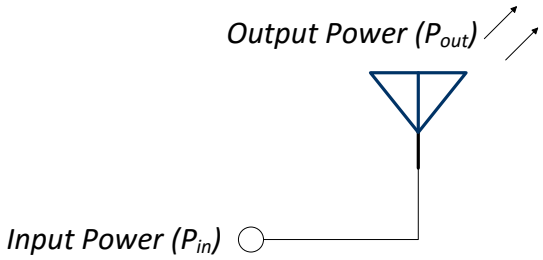

Figure 1: Input/Output Definition

$$\eta_{antenna} = \frac{P_{out}}{P_{in}} = \frac{TRP}{P_{in}}$$

Equation 1: Antenna Efficiency and TRP

This measurement has been fully described and standardized for cellular/mobile and WLAN transmitters by CTIA Certification, a division of CTIA—The Wireless Association©. Specifics of the measurement, as well as derivations, uncertainty calculations, and more are described in the *Over-the-Air Certification Test Plan: Method of Measurement for Radiated RF Power and Receiver Performance*.

Total Radiated Power is measured on an antenna test range, most often an anechoic chamber. The transmitter is excited in some fashion, outputting power to the antenna. The antenna then radiates this power. The measurement system performs power measurements at a discrete set of points scattered through all directions from the antenna. Typically, this means measuring in 5 – 30° increments for every elevation and azimuthal angle. Also typically, power measurements are taken from both vertical and horizontal polarizations. All of these measurements are combined using calculations set forth by CTIA.

As described above, TRP is wholly dependent on two parameters: input power and antenna efficiency. For cellular devices, the power output from the cellular transmitter (often, a cellular module) is fixed, known, and well-controlled. As an engineer integrating a cellular module and an antenna, this places the burden of achieving satisfactory TRP on the antenna efficiency.