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Total Isotropic Sensitivity: A Primer

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Introduction

Total Isotropic Sensitivity (TIS) is a radio frequency (RF) engineering term used to describe the total available receive performance of a device with a real antenna. TIS is expressed in terms of power: Watts (W), milliwatts (mW), or the logarithmic terms for W and mW (dBW and dBm; most commonly, dBm). Antenna efficiency is expressed either in percentage or dB. In Figure 1 below, antenna efficiency, $\eta_{antenna}$, is the ratio of output power to input power.

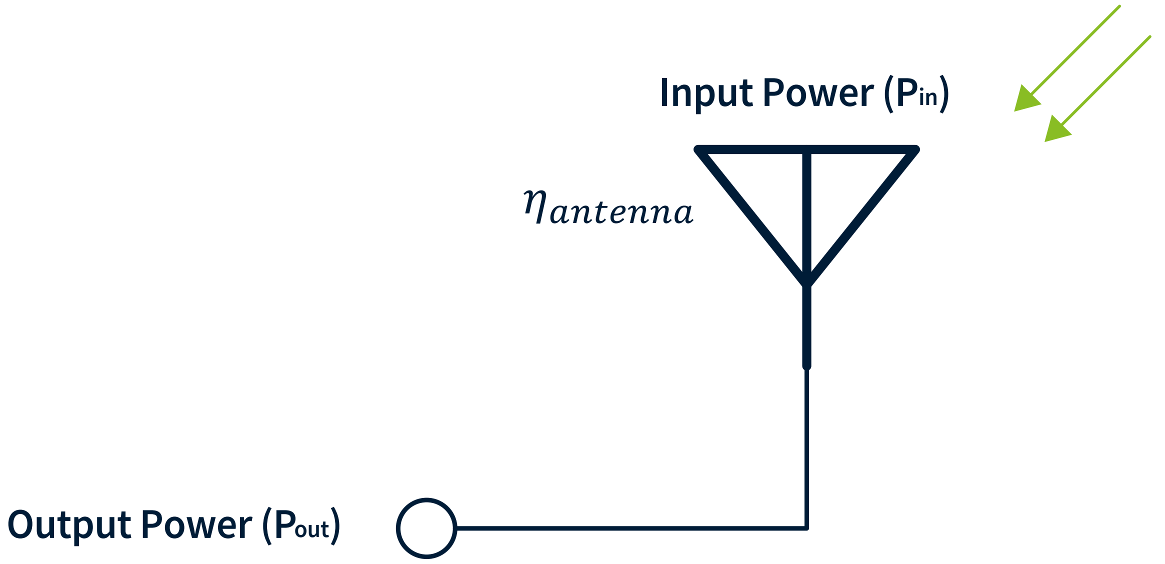

Figure 1: Input/Output Definition

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

Equation 1: Antenna Efficiency

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 Isotropic Sensitivity is measured on an antenna test range, most often an anechoic chamber. An RF signal generator of some sort is used to generate data traffic; the receiver then reports or allows for measurement of data error rate. The power output by the signal generator is slowly lowered until a predefined threshold error rate is reached— this is the receiver sensitivity — in this case called Equivalent Isotropic Sensitivity, or EIS. The measurement system then performs these 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, receiver measurements are taken from both vertical and horizontal polarizations. All of these measurements are combined using calculations set forth by CTIA to form a single TIS result per frequency.

As described above, TIS is dependent on two parameters: receiver sensitivity without the antenna (conducted receiver sensitivity) and antenna efficiency. In real devices, however, another factor can affect TIS: self-interference, also known as self-jamming or self-quieting. These are emissions from the device itself—not necessarily related to the receiver or radio—that are emitted at the same frequency as the signals the receiver is trying to receive.

For cellular devices, the conducted receiver sensitivity of the cellular receiver (often, a cellular module) is wellcharacterized. As an engineer integrating a cellular module and an antenna, this then places the burden of achieving satisfactory TIS on the antenna efficiency and controlling emissions from the system within the cellular frequency bands.

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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.

Enniscorthy, Ireland (HQ)
Unit 5, Kilcannon Business Park, Old Dublin Road
Enniscorthy, Co. Wexford, Y21 XW56, Ireland
+353 53 9169500 | emeasales@taoglas.com

Dublin, Ireland
DCU Alpha, Innovation Campus,
Old Finglas Road, Glasnevin, Dublin 11, Ireland
emeasales@taoglas.com

Munich, Germany
Erika-Mann-Straße 25, Second Floor
80636 München, Germany
+49 89 3803 7426 | emeasales@taoglas.com

San Diego, USA
8525 Camino Santa Fe, Suite A & B,
San Diego, CA 92121, United States
+1 858 450 0888 | nasales@taoglas.com

Minneapolis, USA
15 S. 5th St. Suite 150,
Minneapolis, MN 55402, United States
+1 858 450 0888 | nasales@taoglas.com

Florida, USA
5497 Wiles Rd. Suite 205,
Coconut Creek, FL 33073, United States
+1 954 977 4470 | nasales@taoglas.com

Tainan, Taiwan
4F.-2, No.15, Guoji Road, Xinshi District,
Tainan City 744, Taiwan (R.O.C.)
+886 3 3681223 | asiasales@taoglas.com

Taoyuan, Taiwan
No.2-2 Ln. 66, ZhongShan 1st Rd.,
Bade City, Taoyuan City 33454, Taiwan (R.O.C.)
+886 3 3681223 | asiasales@taoglas.com

Shenzhen, China
Unit 509, Neptune Building, Lanxiang 1st Street,
Nanshan District, Shenzhen 518067, China
+86 755 86538292 | cnsales@taoglas.com

www.taoglas.com