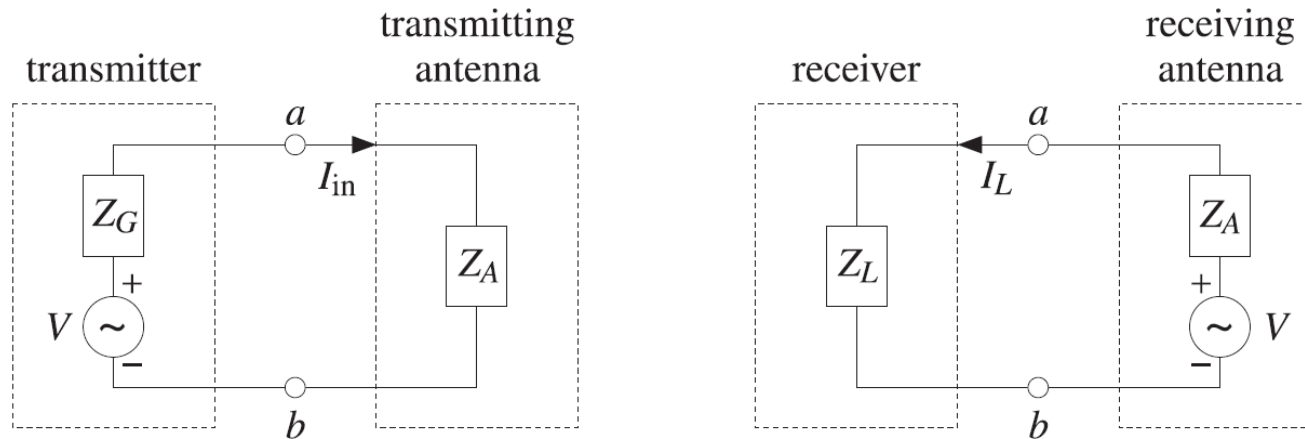# Antennas: Parameters

Impedance

❑ In Tx and Rx the antenna equivalent circuit of the antenna connected to the transmitter or receiver are: Kontuz! Antena hartzailea eskuinean dago!!

❑ In Rx, V is the open circuit voltage of the receiving antenna (V_{CA} circuito abierto in Spanish), as it is the voltage in the antenna terminals when no load is connected.

❑ V will depend on the E field or power density at the antenna location and on the antenna characteristics.

❑ If $Z_A \neq Z_L^*$ then some mismatch losses reduce the power at Z_L .

Antennas: Parameters

Impedance

❑ The antenna impedance is one of the most important parameters. It indicates if a device can be used as an antenna or not.

❑ To measure the impedance normally the network analyzer is used. The impedance can be obtained from the reflection coefficient as follows:

$$\rho = \frac{Z_{in} - Z_0}{Z_{in} + Z_0}$$ Modulia erabiliko dugu gehienetan (edo guztietan).

❑ Usually network analyzers provide Z_{in} measurement directly.

❑ Other measurements related with ρ and consequently with Z_{in} are:

- Return losses: $-20\log|\rho|$

- Voltage Standing Wave Ratio (VSWR) *Relación o Coeficiente de Onda Estacionaria (ROE/COE):*

$$VSWR = \frac{1+|\rho|}{1-|\rho|}$$

- Mismatch Loss: $-10\log\left[1-|\rho|^2\right]$

❑ In transmission, a mismatch between the transmitter and the antenna can cause important damage in the equipment due to the reflected power. So good matching is a critical factor.

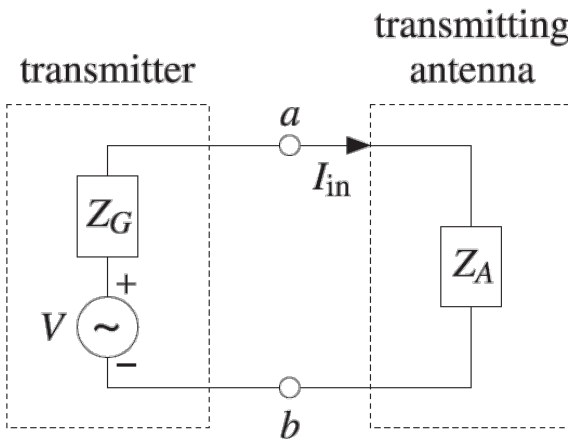# Ejemplos/adibideak- Transmitting antenna 1

Generator Vg=30 V, Zg=50 Ω

a) Power radiated by an antenna with Za=50 Ω

b) Power radiated by an antenna with Za=75 Ω

    b.1) Mismatch losses (linear units and logarithmic units)

    b.2) Reflection coefficient. Mismatch losses (linear and logarithmic)

transmitter

transmitting antenna

I_{in}

Z_G

Z_A

V

a

b

a) $P_{rad}|_{Za=50}$ = 4.5 W

b) $P_{rad}|_{Za=75}$ = 4.32 W

    b.1) Mismatch losses= $P_{rad}|_{Za=75} / P_{rad}|_{Za=50}$ = 0.96

    Mismatch losses= $10\log 10[P_{rad}|_{Za=75} / P_{rad}|_{Za=50}]$= -0.177 dB

    b.2) ρ=0.2

$$\left[1-|\rho|^2\right]=\left[1-0.2^2\right]=0.96$$

$$10\log\left[1-|\rho|^2\right]=10\log\left[1-0.2^2\right]=-0.177 \text{ dB}$$

The generator can provide 4.5 W to a matched antenna. Due to mismatch, the 75 Ω antenna gets 4.32 W. This suppose -0.177 dB mismatch losses.
Mismatch losses can also be calculated from the reflection coefficient.

Generator nominal power: the power dissipated by a load which impedance is equal to the generator impedance.

Ejemplos/adibideak- Receiving antenna 1

Receiving antenna Za=50 Ω. Receiver with Z_L=75 Ω

a) Reflection coefficient. Mismatch losses (linear and logarithmic)

b) Ratio between power received by the receiver with Z_L=75 Ω and power received by the antenna (Za=50 Ω).

c) If the antenna takes 1 mW, how much does the receiver take?

receiver

receiving antenna
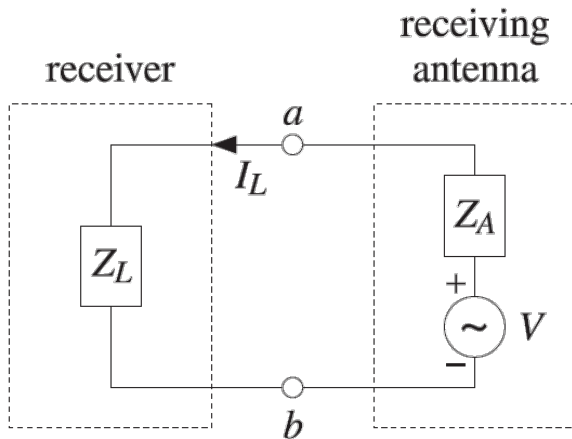
a) ρ=(75-50)/(75+50)=0.2

$$\left[1-|\rho|^2\right]=\left[1-0.2^2\right]=0.96$$
$$10\log\left[1-|\rho|^2\right]=10\log\left[1-0.2^2\right]=-0.177 \text{ dB}$$

b) $P_{receiver}$/ $P_{antenna}$ = mismatch losses = 0.96

c) $P_{receiver}$=$P_{antenna}$·mismatch losses=1·0.96 = 0.96 mW
$P_{receiver}$(dBm)=$P_{antenna}$(dBm) - mismatch losses(dB)=
=10*log(1) − 0.177= -0.177 dBm

The antenna takes 1 mW. Due to impedance mismatch, the 75 Ω receiver gets 0.96 mW. This suppose -0.177 dB mismatch losses.

Ejemplos/adibideak- Receiving antenna 2

Receiving antenna Z_A=50 Ω taking 1 mW power. How much power would a receiver with Z_L=100 Ω take?

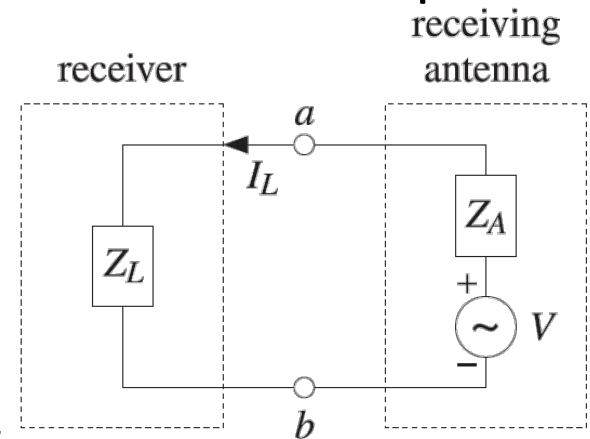receiver   receiving antenna

Solution:

Reflection coefficient ρ=(100-50)/(100+50)=1/3

$$1-|\rho|^2 = 1-(1/3)^2 = 0.889$$
$$10\log\left[1-|\rho|^2\right] = 10\log\left[1-(1/3)^2\right] = -0.51\,\text{dB}$$

$P_{receiver}$=$P_{antenna}$·mismatch losses=1·0.889 = 0.889 mW
$P_{receiver}$(dBm)=$P_{antenna}$(dBm) - mismatch losses(dB)=10*log(1) − 0.51= -0.51 dBm

Matched impedances Z_L=Z_A=50 Ω, power in Z_L=1 mW, we can calculate V

$$P_{Z_L=50\Omega} = \left|\frac{V}{Z_A+Z_L}\right|^2 \cdot Z_L \Rightarrow V = \sqrt{\frac{P_{Z_L}}{Z_L}}\cdot(Z_A+Z_L) = \sqrt{\frac{10^{-3}}{50}}\cdot(50+50) = 0.4472\,\text{V}$$

Mismatched impedances Z_L=100 Ω, Z_A=50 Ω

$$P_{Z_L=100\Omega} = \left|\frac{V}{Z_A+Z_L}\right|^2 \cdot Z_L = \left|\frac{0.4472}{50+100}\right|^2 \cdot 100 = 0.889\,\text{mW}$$