Structured Electronic Design

EE3C11
Design of the Active Antenna
Understand the Application

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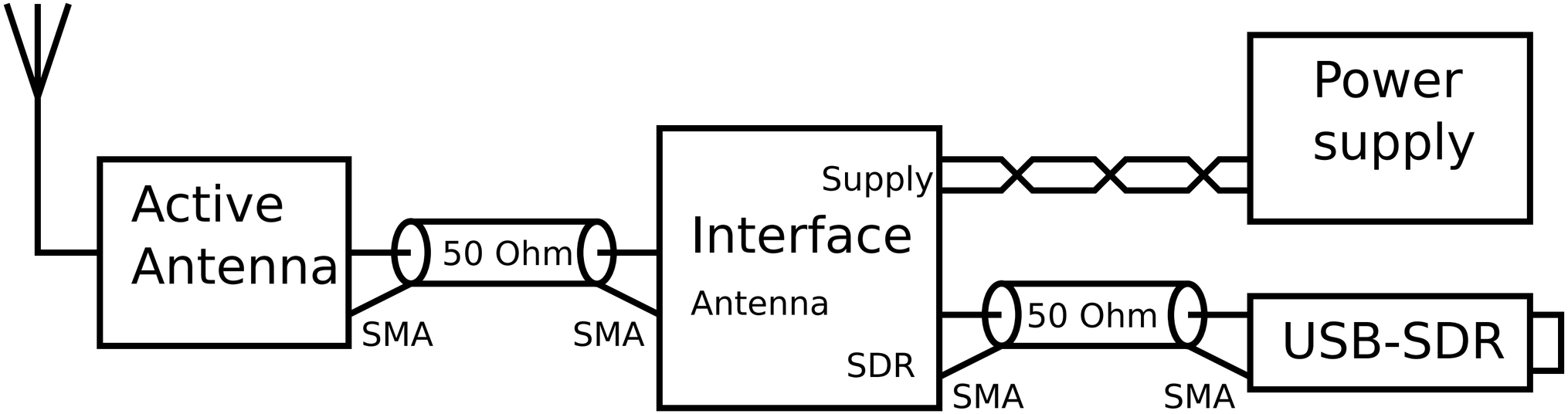
Understand the application



In which way do the voltage and current generated by the antenna depend on the E-Field?

Do we need an amplifier?

How to combine and split supply power from signal power?

The Antenna

A whip antenna (short rod) is often applied as E-field sensor

Its open-circuit voltage depends on the E-field and on its length

For frequencies at which its length is smaller than a quarter of the wavelength $\ell \ll \frac{\lambda}{4}$

its electrical equivalent circuit can be represented by an ideal voltage source in series with a linear capacitor.

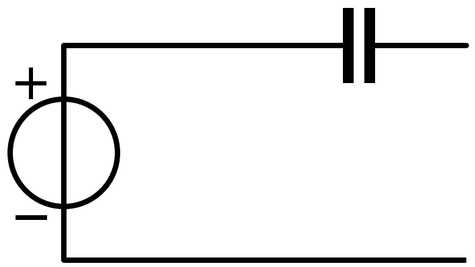
For an improved model, see:

Tee G. Tang, Quang M. Tieng, and Moms W. Gunn
Equivalent Circuit of a Dipole Antenna Using Frequency-Independent Lumped Elements

IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION,
VOL. 41, NO. I , JANUARY 1993

$$\ell = 0.5\text{m}$$
$$d = 5\text{mm}$$
$$V \approx 0.5\,E\ [\text{V}]$$

$$C \approx 6.4\text{pF}$$



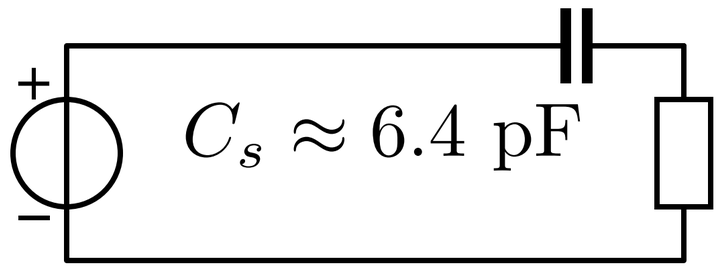
The Amplifier

An amplifier is used to obtain an accurate copy of an electrical signal with an increased available power

How much signal power delivers the antenna if we terminate it with a resistance that is large enough to guarantee a flat frequency response over the desired frequency range?

Given a -3dB frequency range from 10kHz ... 30MHz and the source capacitance 0f 6.4pF, we can calculate the minimum load resistance:

$$R_\ell \approx \frac{1}{2\pi f_{\min} C_s} = 2.5\ \mathrm{M\Omega}$$



$V_s \approx 0.225$ V

$R_\ell = 2.5\ \mathrm{M\Omega}$

$P_\ell = \frac{V_s^2}{R_\ell} = 20.3\ \mathrm{nW}$

Required load power at this antenna voltage is 4 mW. Hence, amplification is required.

The Interface

The function of the interface is to split/combine the supply power and the signal power

The supply voltage is a DC voltage that carries no information

The signal has information in a frequency band between 10kHz and 30MHz

Supply voltage and signal voltage an be split/combined with the aid of filters