

Important concepts of antennas

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Topics to be cover

- Terms
- What causes radiation
- Current distribution
- Mutual Inductance
- Ground

Possible other topics needing detail

Antenna simulation -- NEC/EZNEC

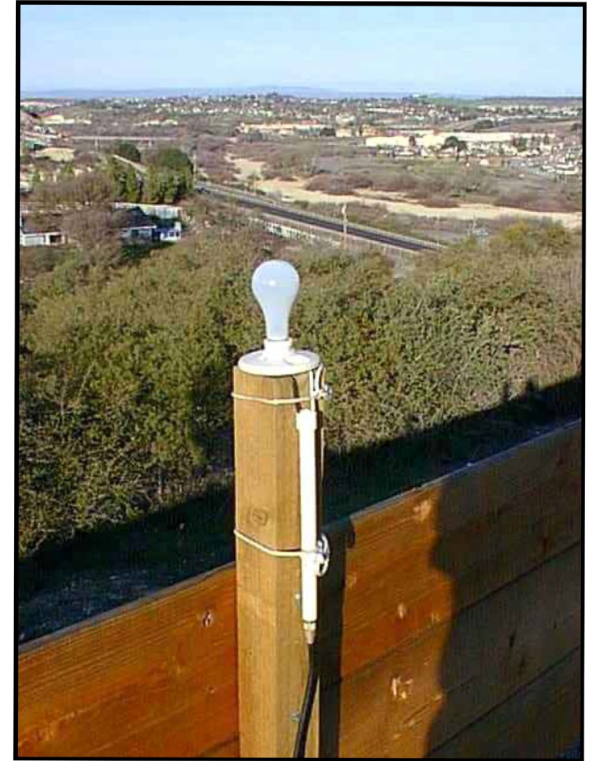
Measuring antenna – VNA / far field testing

Propagation – Prediction / elevation

Terrain Analysis

Everything works

Tom's N6BT 'illuminator' ant
Worked WAC in a weekend
As seen in July 2000 QST



Everything works

A better antenna == more fun.

Topic is:

Important concepts about antennas....

First some basic terms...

Free space

When an antenna is near nothing.

Think of the Voyager space craft.

The ideal environment for comparing antennas

Nothing like reality

Isotropic radiator

A theoretical antenna that radiates in all directions equally well in free space.

Antenna gain is specified as dBi

How to make you antenna appear to be great

dBd

The dB of gain of an antenna referenced to a half wave resonant dipole in free space.

A somewhat more useful reference.

Conversion: A dipole is +2.15 dBi

The single wire antenna

The most basic antenna....

Question:

What is the current at the ends of a single wire antenna.

Single wire antenna

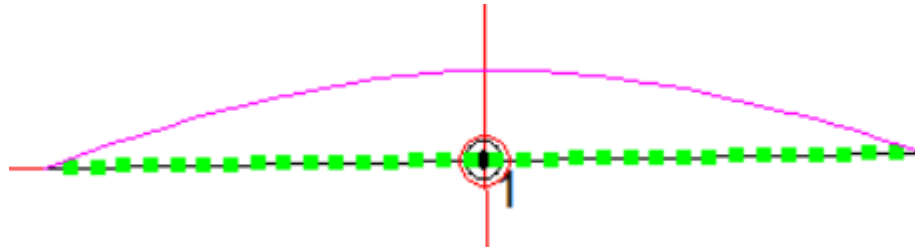
Answer: Zero --- unless it is arcing.

Question: What causes the single wire antenna to radiate?

Single wire antenna

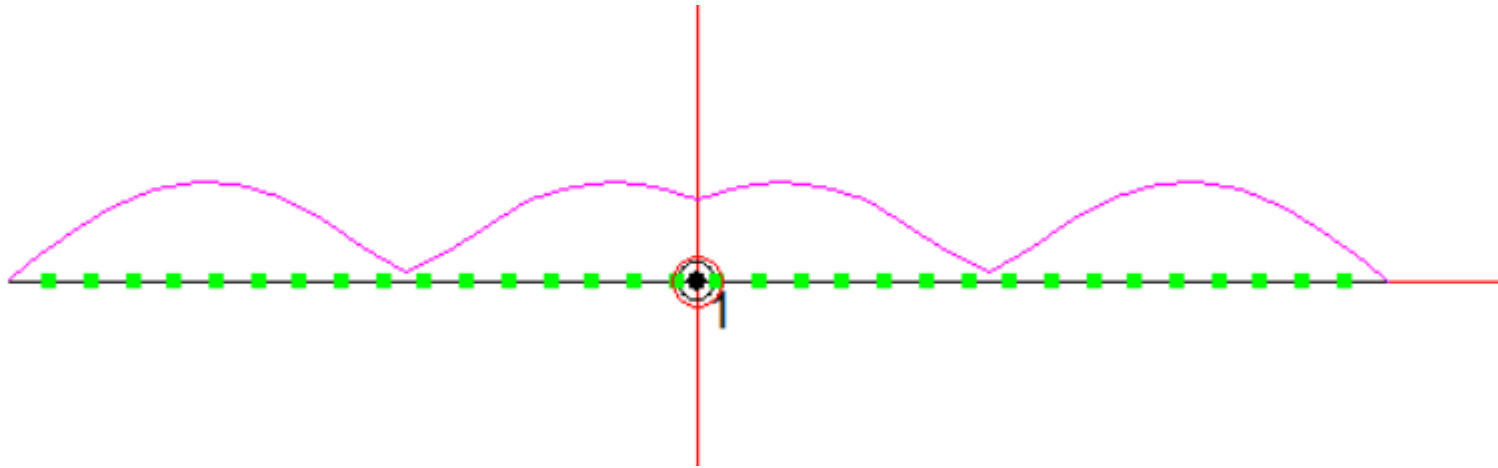
Answer: CURRENT

Any single wire antenna is constrained by the ends ... and will have a current distribution so that the current at the ends will be zero



Single wire antenna

Example of a current distribution when power is applied to the center of a longer antenna



Single wire antenna

MATH ALERT!

The radiation pattern of an antenna is the three dimensional Fourier transform of the current distribution.

Be thankful for computers..

Single wire antenna

Special case: Resonant half wavelength
“dipole” antenna

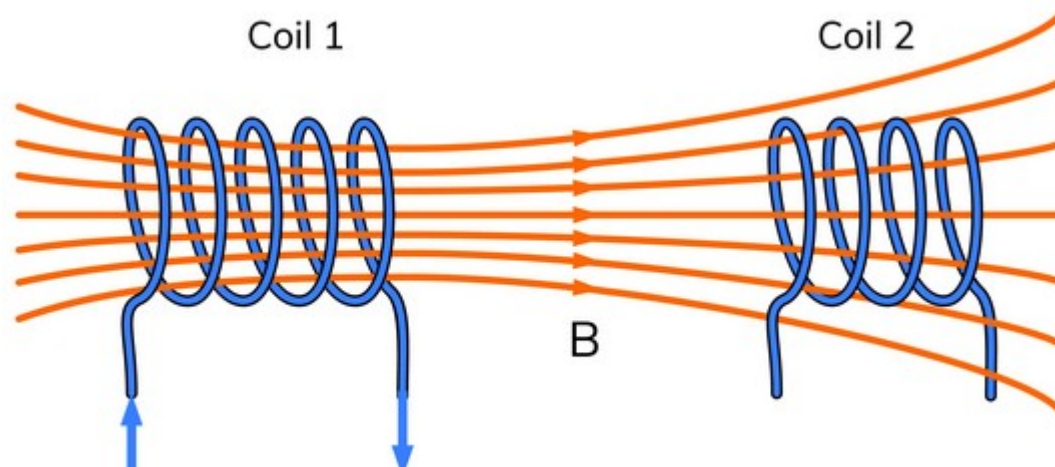
If fed anywhere, will be resistive (no L or C)

If fed in the center, the resistance will be the lowest (lowest ratio of voltage / current) and will be balanced.

Mutual Inductance

When a driven antenna magnetic field causes a current to be induced into another conductor

Usually the term is thought of with respect to a transformer... but it applies to antennas.

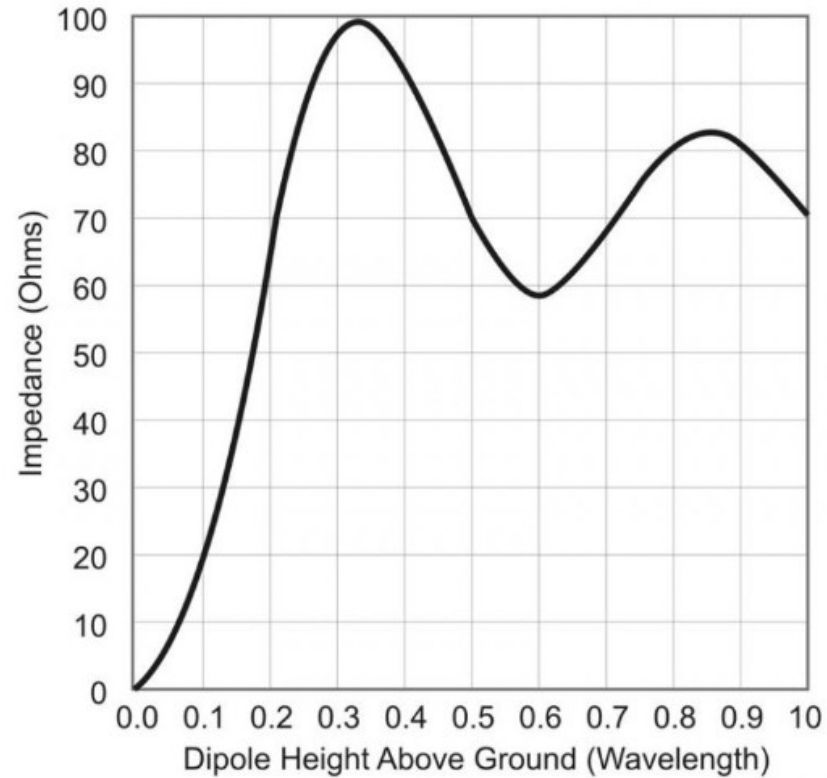


Mutual Inductance

Since the driven element causes a current to flow in the other elements... it will cause a change in the drive point impedance

eg: impedance of a dipole as a function of heights above ground

Mutual Inductance



Mutual Inductance

Can be your friend:

Spacing near resonant elements near driven element, can create a phased array, better known as a Yagi-Uda.

Mutual Inductance

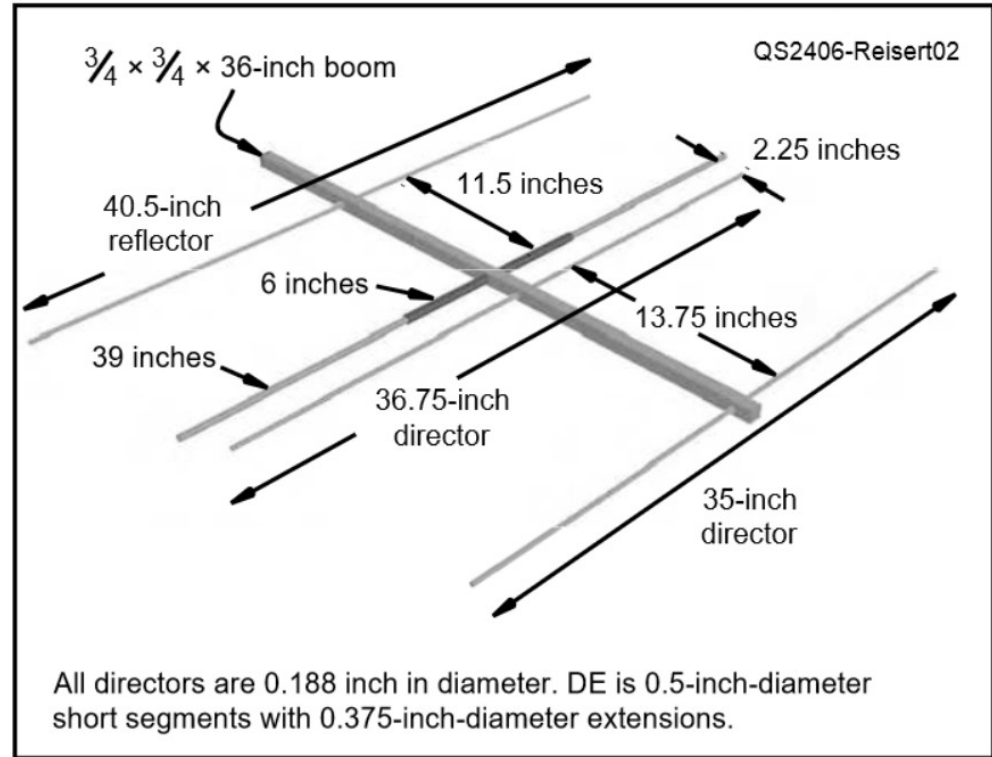
Can be your friend:

Placing a near resonant element near a driven element can increase the drive impedance and increase the bandwidth.

Parasitic driven element

Mutual Inductance

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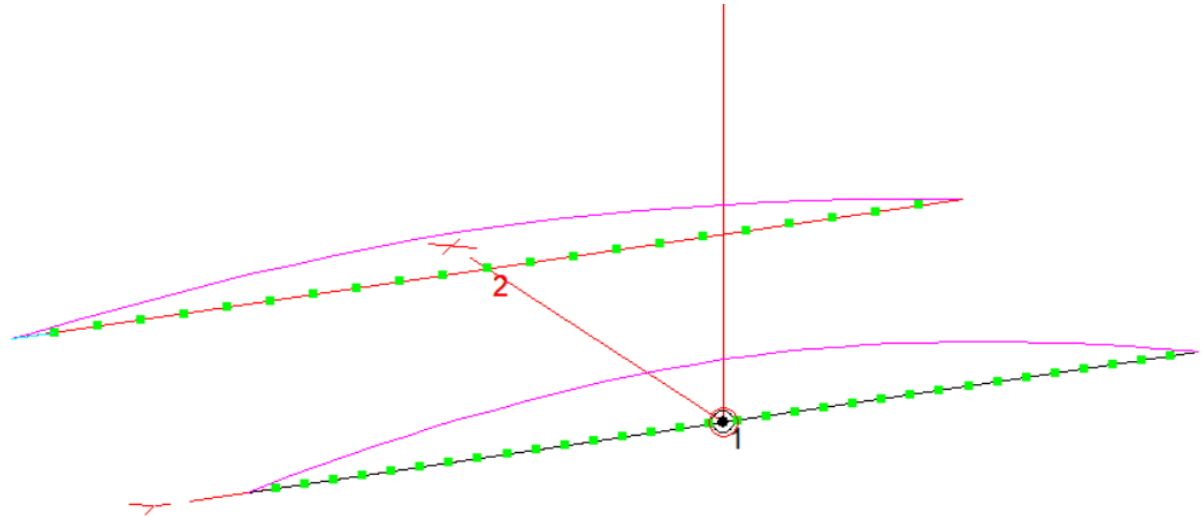
Mutual Inductance

Can be your foe:

Rain gutters, flashing strips, screens, ground...
will have induced currents that will alter the
impedance of the antenna and alter the pattern.

Mutual Inductance

How much is the effect? Depends on **size**, **length** of the object and **distance**, **orientation**.
Best case equal size, resonant....



Mutual Inductance

$\frac{1}{4}$ wavelength = 65%

$\frac{1}{2}$ wavelength = 41%

1 wavelength = 24%

2 wavelength = 12%

Mutual Inductance

Worst case... non-resonance equal diameter

$\frac{1}{4}$ wavelength = 10%

$\frac{1}{2}$ wavelength = 6.5%

1 wavelength = 4%

Where is the power going

Power is going somewhere... either as radiation into the 'ether' or as heat.

You can heat:

Antenna bits: Coax, antenna, coils, tuners

Mutual bits: Ground, rain gutters, flashing

Where is the power going

Where is the radiation going?

Hopefully to whomever you're contacting.

Radiation into deep space, won't help.

Where is the power going

MUF = Maximum Usable Frequency

Highest frequency where the **ionsphere** will reflect it back to earth.

Critical Frequency

Highest frequency where a signal going straight up will be reflected back to earth.

Unfortunately....

We are on earth and not in free space, and we have to consider 'ground'.

Ground is messy, and dirty.... And difficult.

It is ... very BIG... and important.

But first consider a 'perfect ground'

Perfect ground

An infinite flat sheet of zero resistance conductor. (not practical)

A perfect ground will act like a mirror, and the antenna will appear to be duplicated below the perfect ground.

Earth's closest thing to a 'perfect ground'

A Calm Ocean....

Salt water is a decent conductor

A lossy mirror.... But is still really decent.

Ground Ground

Depends on many many factors... including:

- Moisture
- Soil composition
- Salt Composition