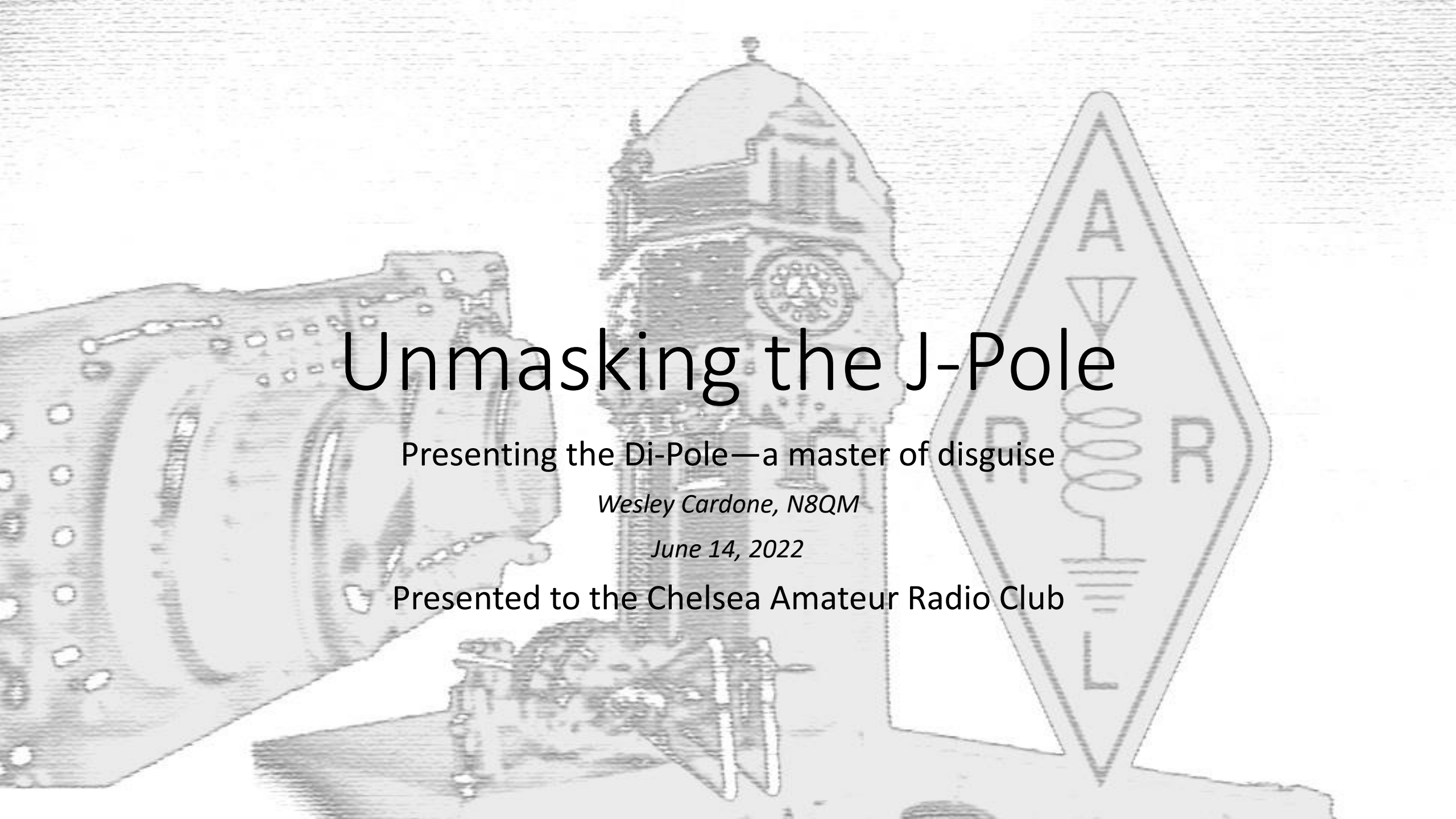


Unmasking the J-Pole

Presenting the Di-Pole—a master of disguise

Wesley Cardone, N8QM

June 14, 2022

Presented to the Chelsea Amateur Radio Club

What to Expect to Walk Away With

- If you know nothing of electronics:
  - Expect to leave understanding fundamental concepts
- Maybe you have seen and recognize these things before but have no full grasp of them.
  - Expect to have a much better intuitive feel for how they work.
- Someone having had formal training in basic electronics
  - Expect to leave confident of how these things work.
- Someone who is constantly exposed to electronics and designs.
  - You will have a much more intuitive feel and confidence for how these things work.

What is Presented Tonight

- Reactances
  - Capacitive
  - Inductive
- Voltage and Current relationships in
  - electro-magnetics
  - On a di-pole antenna
- The workings of the di-pole antenna
- The workings of the J-Pole antenna

Reactance—What is it?

- Here is what Merriam-Webster says the verb form is.
- “Reactance” is a noun.
  - You tell me what reactance means.
- Does reactance incorporate time?

react verb

Save Word

re·act | \ rē-ˈakt \

reacted; **reacting**; **reacts**

Definition of *react*

intransitive verb

1 : to exert a reciprocal or counteracting force or influence —often used with *on* or *upon*

2 : to change in response to a stimulus

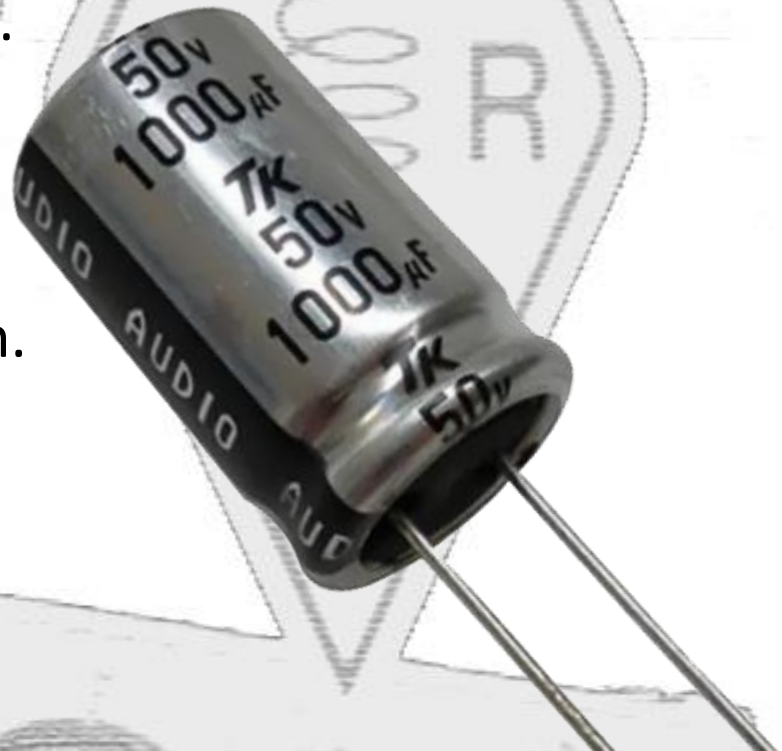
3 : to act in opposition to a force or influence —usually used with *against*

4 : to move or tend in a reverse direction

5 : to undergo chemical reaction

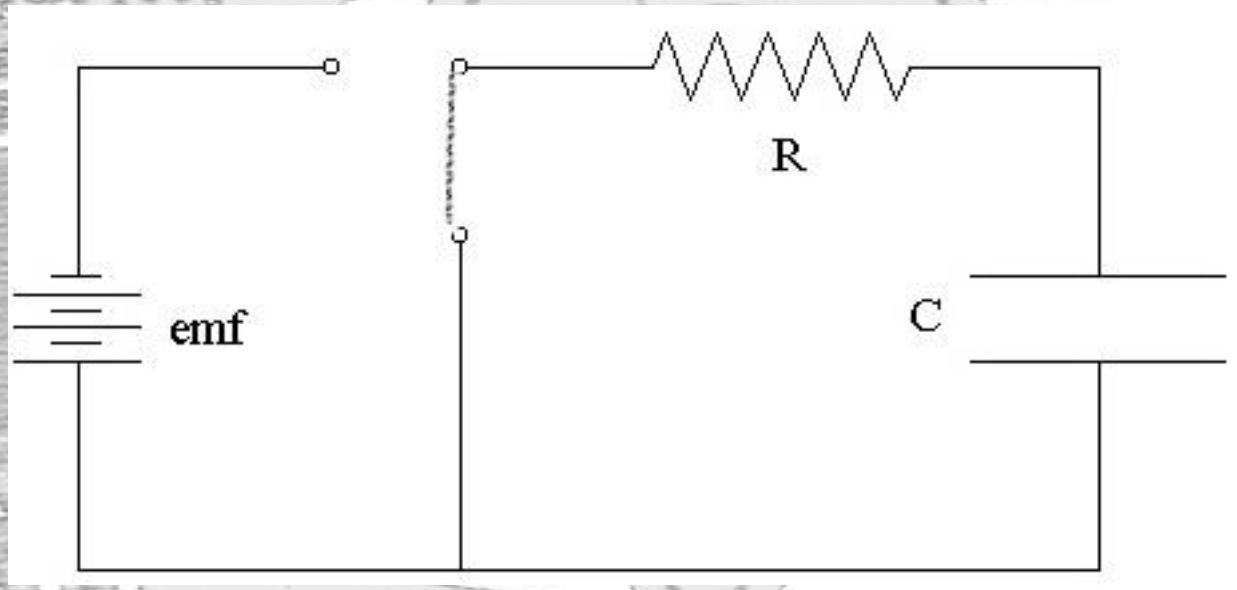
Understanding Capacitive Reactance

- A capacitor is initially a closed circuit to current.
  - At voltage application it looks like a short.
- When voltage is instantaneously applied,
  - Because the capacitor initially looks like a short…
  - Voltage is zero initially
  - But current freely flows at a maximum but begins to lower toward zero current flow.
  - The capacitor is “reacting” to voltage application.



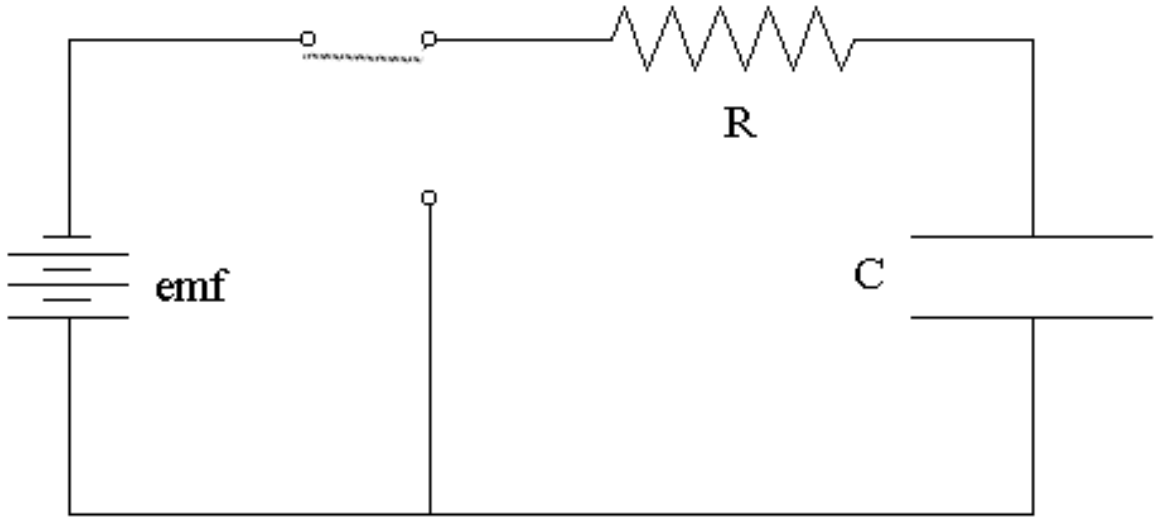
Capacitive Reactance

- This is an RC (resistance/capacitance) circuit
- EMF source is DC (a battery)
- The switch (SPDT) is initially shorted to ground.
- Shown here, the capacitor has
  - no voltage appearing across it.
  - No current flow.



Capacitive Reactance Transient Response

- The switch was open but suddenly closed and thereby applies potential to the circuit.
- EMF source is again a battery or DC.
- When the switch closes the capacitor:
  - Still has no voltage appearing across it but, with time, begins to build voltage.
  - The capacitor has maximum current flow but with time, begins to decay toward zero.



What is Phase, anyhow?

- We will be looking at two related signals in the time domain that are…
  "out of phase."

Merriam-Webster SINCE 1828

Definition of *phase* (Entry 1 of 2)

1 : a particular appearance or state in a regularly recurring cycle of changes
// phases of the moon

2 **a** : a distinguishable part in a course, development, or cycle
// the early *phases* of her career

b : an aspect or part (as of a problem) under consideration

3 : the point or stage in a period of uniform circular motion, harmonic motion, or the periodic changes of any magnitude varying according to a simple harmonic law to which the rotation, oscillation, or variation has advanced from its standard position or assumed instant of starting

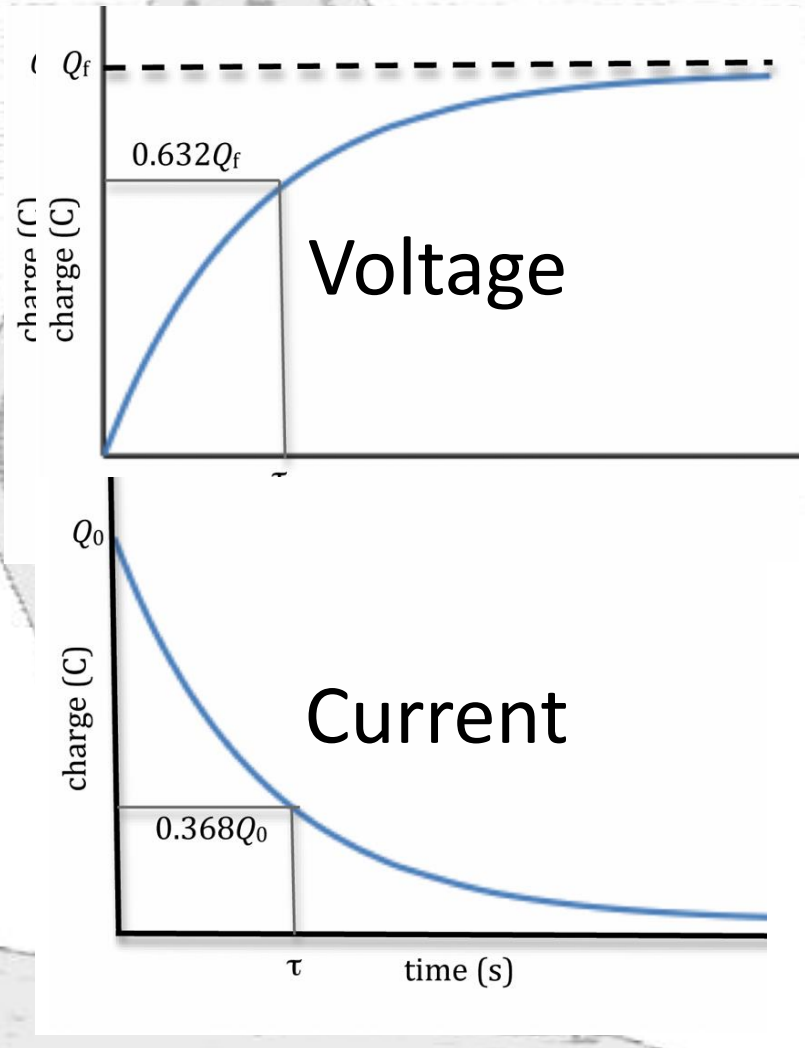
4 : a homogeneous, physically distinct, and mechanically separable portion of matter present in a nonhomogeneous physicochemical system

5 : an individual or subgroup distinguishably different in appearance or behavior from the norm of the group to which it belongs

also : the distinguishing peculiarity

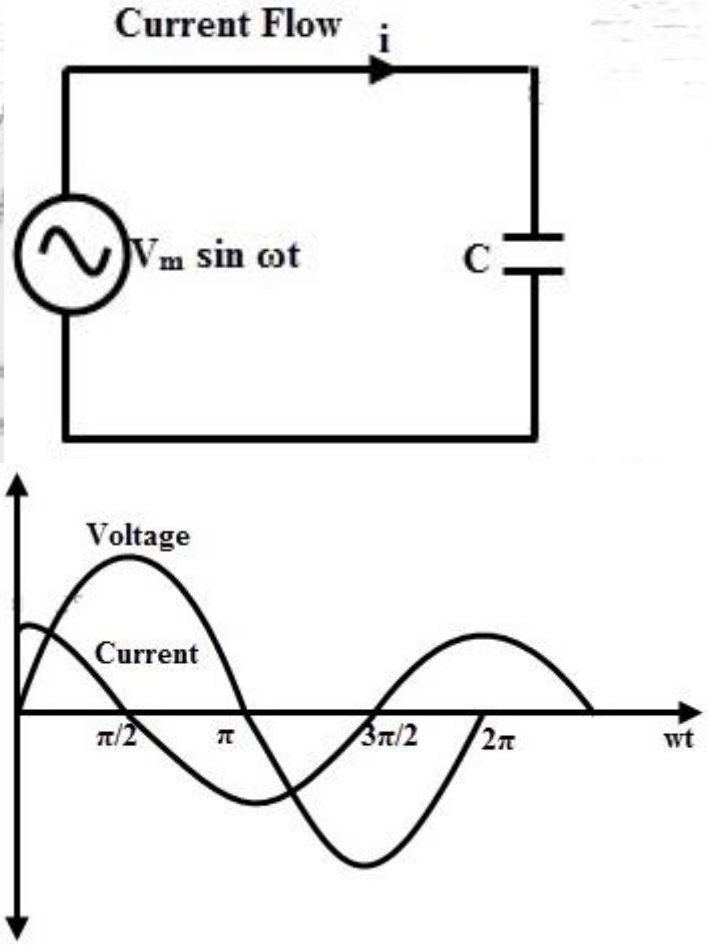
Phase of Voltage and Current--Capacitive

- What is the phase relationship in a capacitive circuit of the two signals, voltage and current?
- The answer is NOT intuitive yet:
  - Voltage leads (comes before) the current
  - Current leads (comes before) the voltage
- Think of it this way:
  - We get current first (leads)
  - We get voltage last (lags)



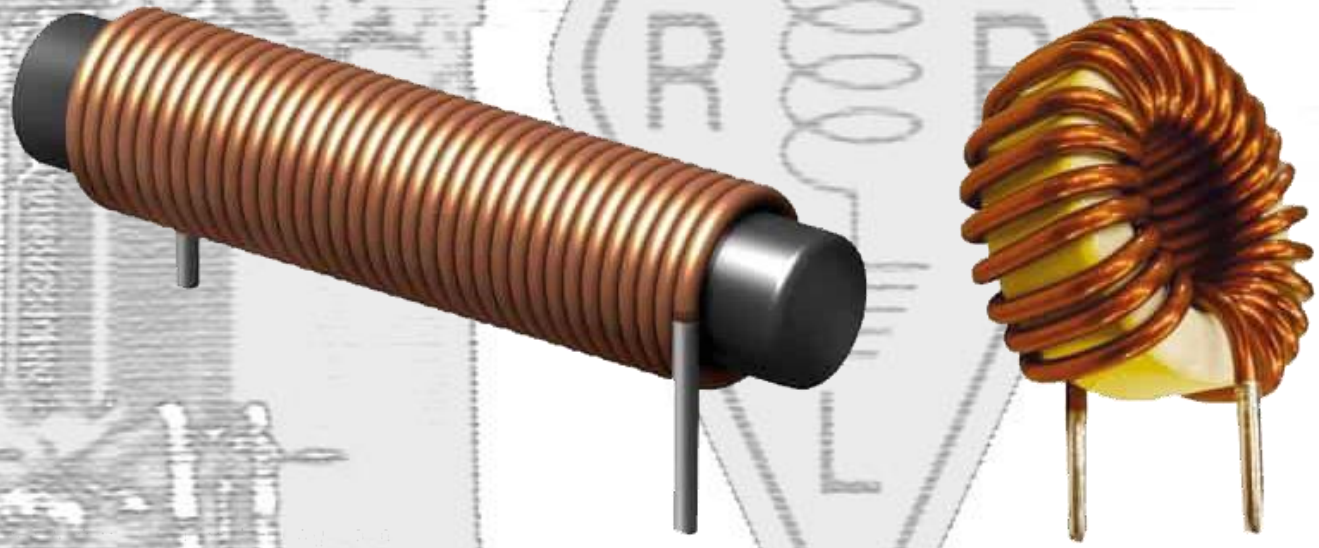
Capacitive in an AC Circuit

- To make phase intuitive we switch from the time domain to the frequency domain.
- DC is now AC so we drop the switch
  - Polarity effectively switching ON and OFF constantly somewhat like a switch.
- Phase relationship now finally becomes intuitive.
  - The current comes first
  - Followed by the voltage
  - Therefore, current LEADS the voltage
- Further, now we can double back to see intuitively in the time domain.



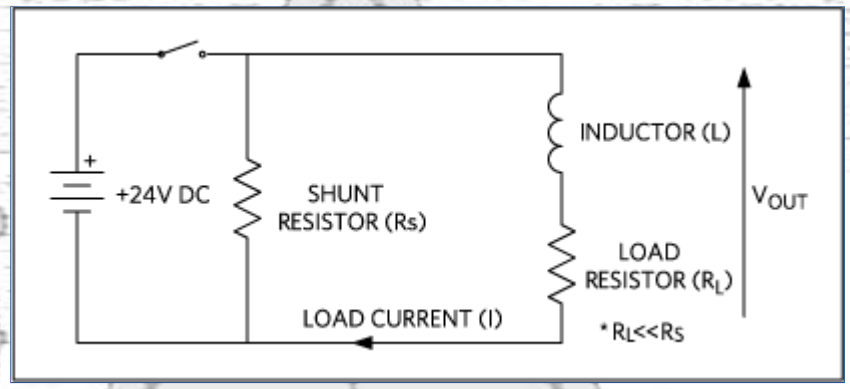
Inductive Reactance

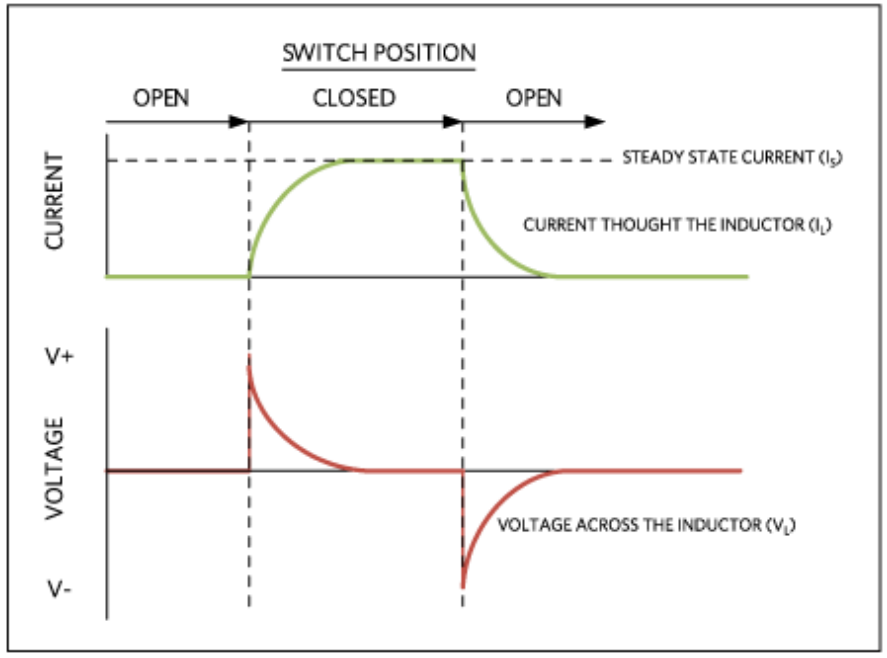
- An inductor initially opposes current flow changes.
- At an initial voltage application an inductor looks like an open.
  - If you don't know what an "open" is, it will be shown in a couple of slides.



Inductor in Time Domain

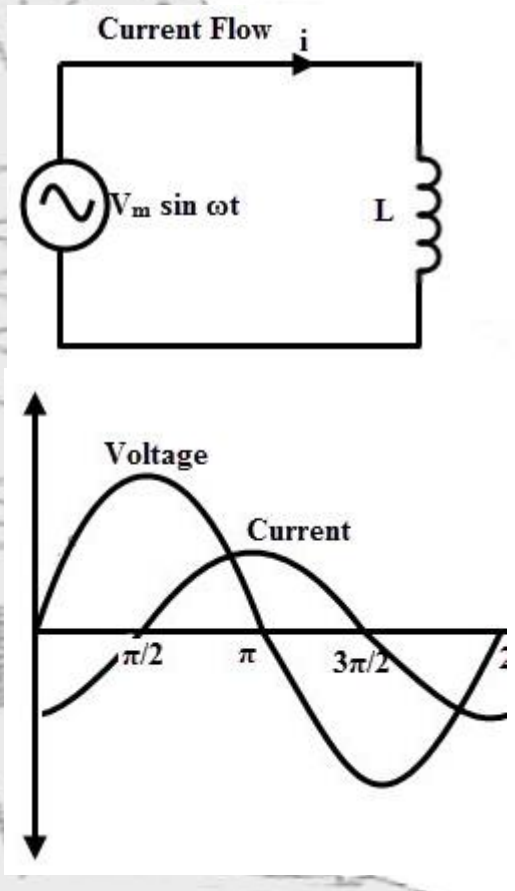
- Start with switch open
  - Any energy drains from circuit to ground.
- Switch closes
  - Places potential across shunt resistor and the series inductor-resistor pair.
  - Inductor refuses to conduct any current initially and therefore drops the full DC potential.
  - Load resistor drops nothing.
- With time…
  - Inductor conducts some current
  - Load resistor shares that same current and drops an Ohm's Law worth of voltage.
- Not intuitive yet: Voltage leads current.





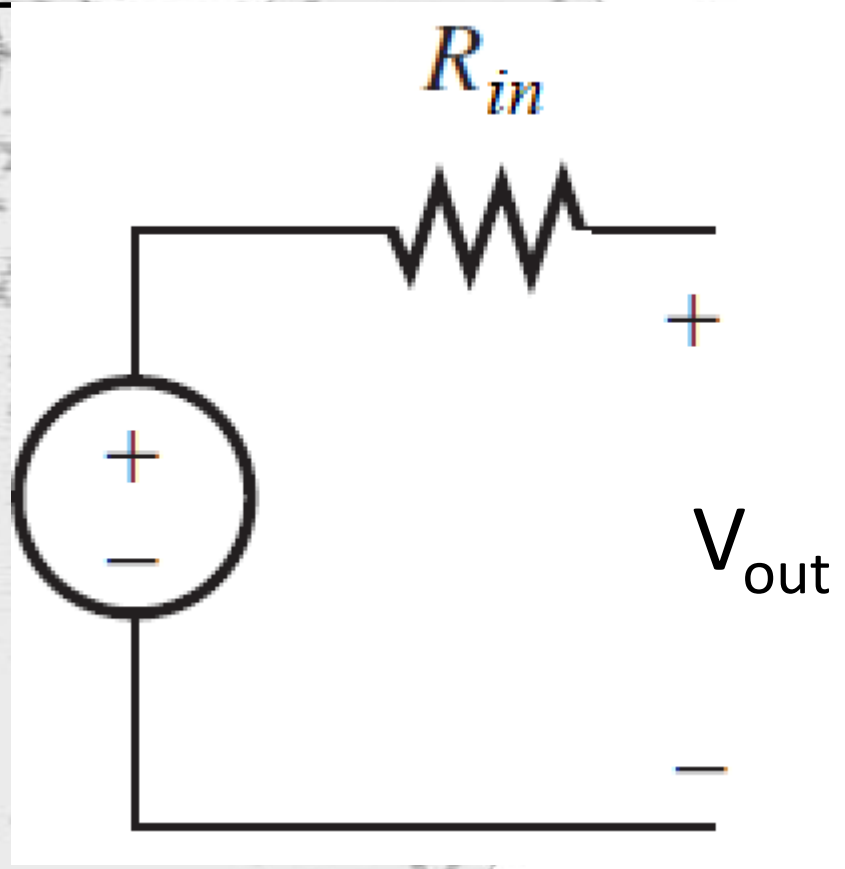
Voltage and Current in Frequency Domain

- What is the phase relationship in an inductive circuit of the voltage with respect to the current?
  - Voltage leads (comes before) the current
  - Current leads (comes before) the voltage
- Why?
  - Potential changes trying to push a current change but the inductor refuses any change at that instant in time.
  - Potential across the inductor rises to satisfy Ohm's Law.
  - Inductor allows some current change with time.
  - Voltage then decreases to continue satisfying Ohm's Law.
- Further, now we can see intuitively in the time domain.



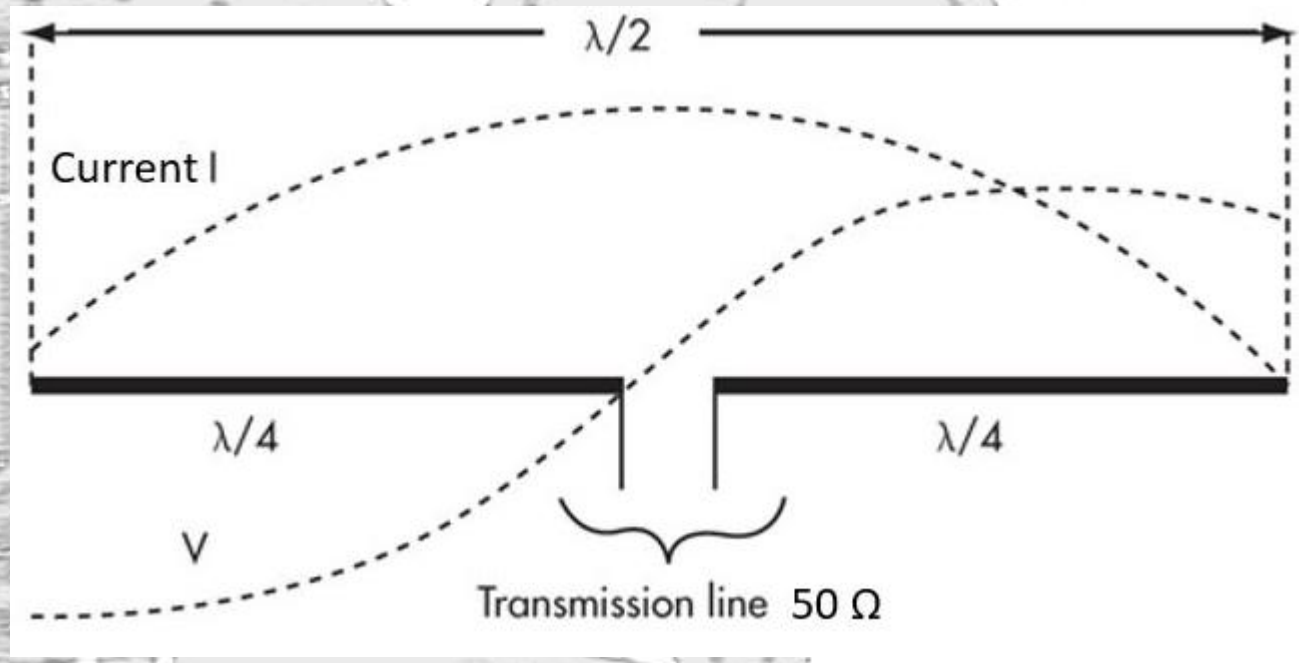
One Last Basic Electronics Concept

- This may seem dumb but is **incredibly illustrative**.
- What is the voltage appearing at the output?
  - Zero
  - Minimum
  - Maximum
- What current exists in this circuit?
  - Zero
  - Minimum
  - Maximum



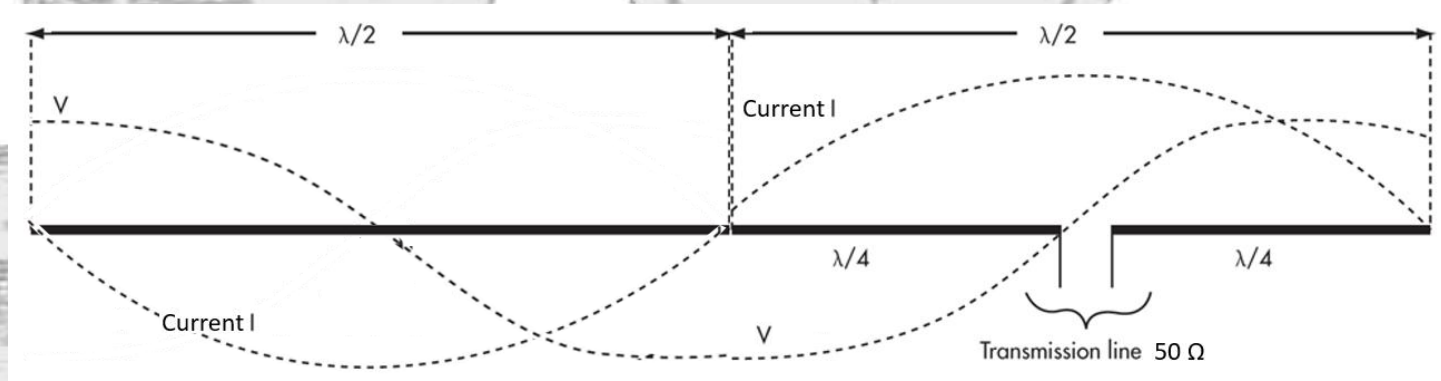
Dipole Voltage and Current Distribution

- Energy Distribution at both ends (but opposite polarity):
  - Voltage is maximum—Why? *(this is critical to understand!!!)*
  - Answer: open circuit
- Since voltage at ends is max, then voltage at the feed point (middle) must be minimum or zero.
- Therefore, what is the input impedance?
  - High (about 2k to 5k Ohms)?
  - Low (about 50 Ohms)?
  - Why your choice of answer?
  - It's all about Ohm's Law.



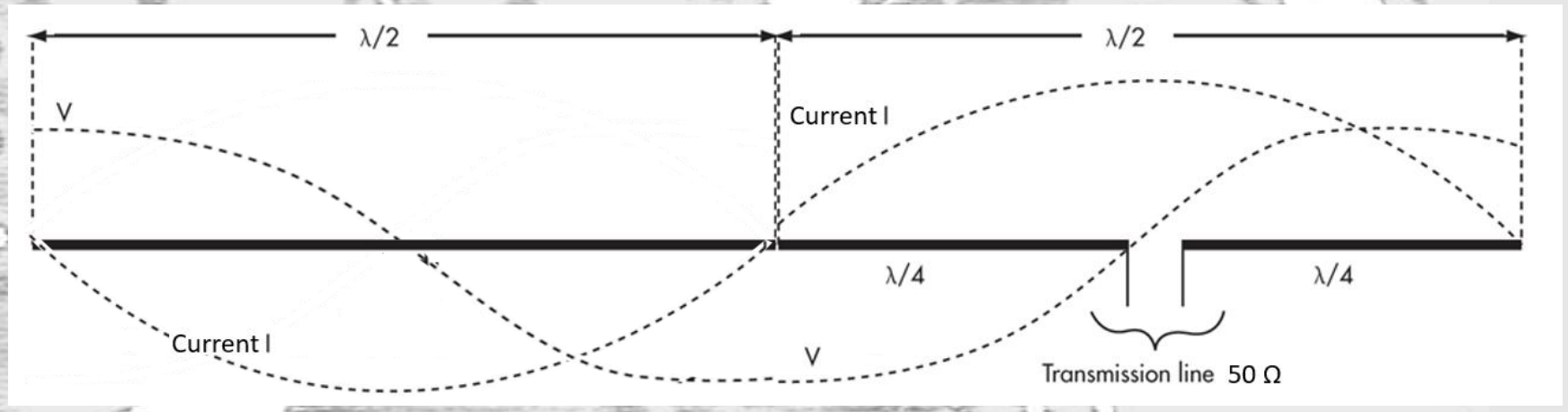
A Full Wavelength

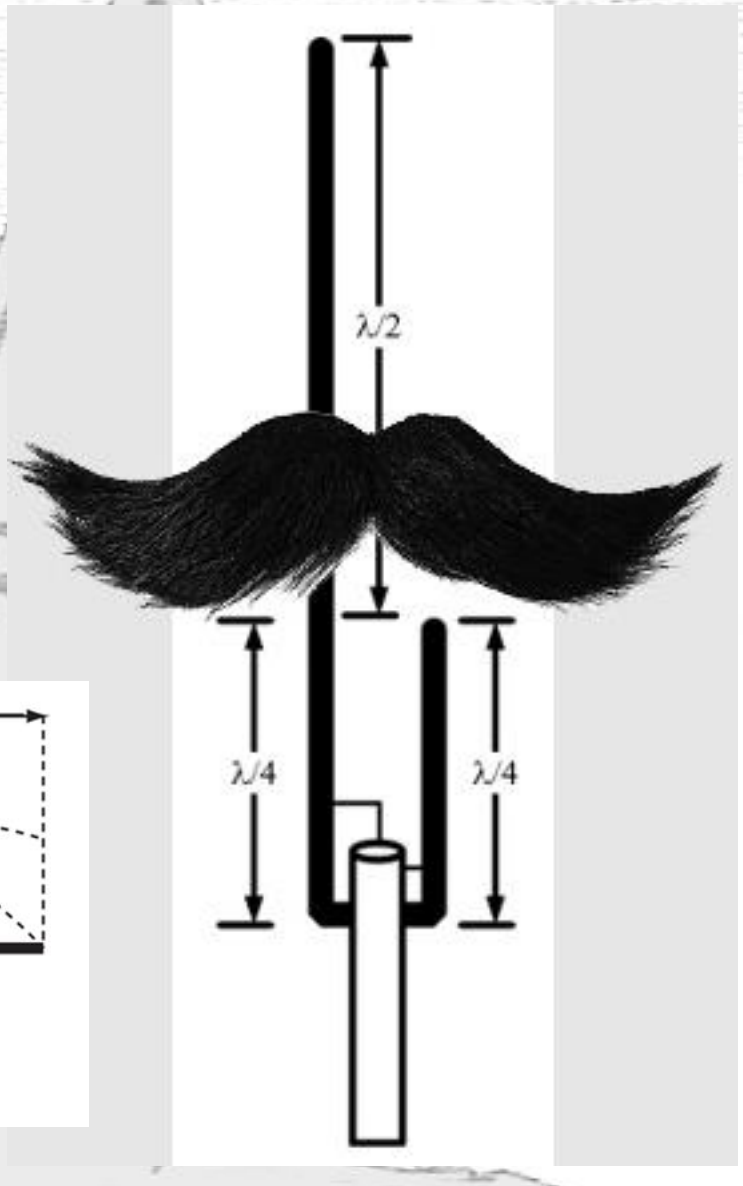
- Enter a FULL WAVE dipole.
  - Feed point impedance is 50 Ohms
  - It is resonant but doesn't work.
- Why will a full wavelength dipole antenna NOT work?
- How about a 1 ½ wavelength antenna?
- Do not dismiss these as trivial concepts. They are critical if you are going to be an innovator.



Introducing the J-Pole Antenna

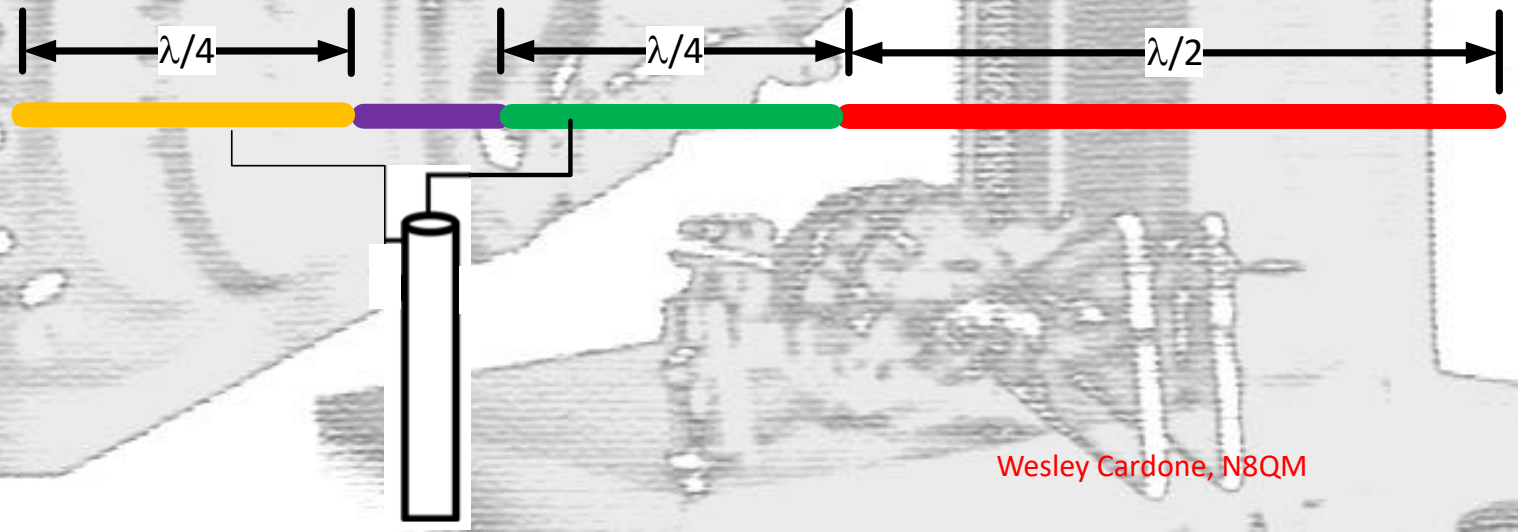
- He's really a
  - full-wave di-pole antenna in disguise or
  - An end-fed half-wave di-pole in disguise.
- But full-wave di-pole's don't work!!!

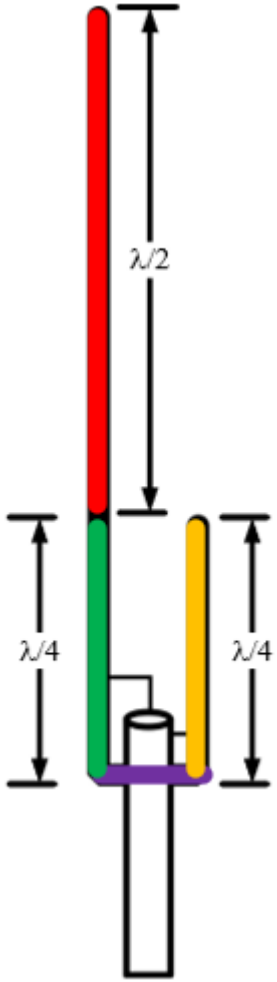




Ripping Off the Disguise

- When we unfold the J-Pole…





Watch an Annimation…

But wait a minute… We learned in
The Mighty Dipole Part I
*that full-wave dipoles **don't work**! There must be an ODD count of half-waves. Even counts cancel themselves. But we already know from empirical results that J-Poles work.*

Wesley Cardone, N8QM

Questions?