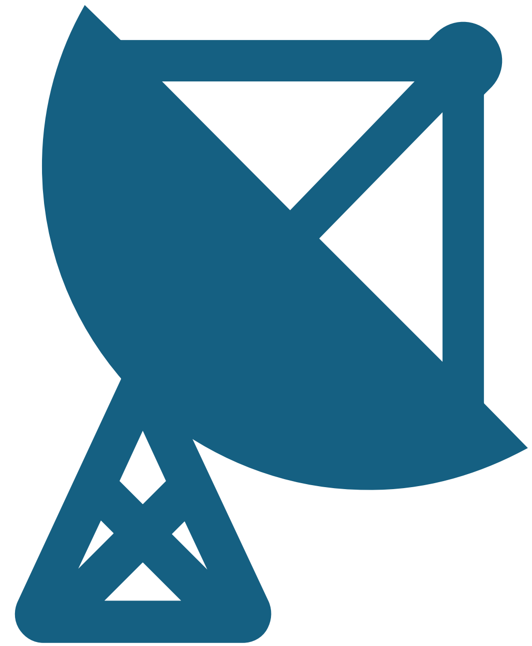
Understanding Antennas: Dipole, Off-Center Fed Dipole, and End-Fed Half Wave (EFHW)



A high-level overview of key differences, characteristics, and applications

By

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Introduction

- **Agenda**:
  - Explore basic antenna concepts.
  - Compare the dipole, off-center fed dipole, and EFHW antennas.
  - Highlight applications and use cases.

Basic Concepts

Key Terms:

- **Balanced vs. Unbalanced:** Managing electro magnetic radiation patterns in the feedline.
- **Resonance**: Efficiency at a specific frequency.
- **Impedance:** Is **resistance** plus **reactance.**
  - **Inductive Reactance**: Occurs when the antenna behaves like an inductor, increasing opposition as frequency increases
  - **Capacitive Reactance**: Occurs when the antenna behaves like a capacitor, decreasing opposition as frequency increases
- **Resonant Frequency: Inductive** and **Capacitive** Reactance cancel each other out - net **Reactance** is ZERO
- **Feed Point**: Connection point for the transmission line.

What all this means: Your radio wants to see 50 ohms at its SO-239 antenna jack, and you use these Basic Concepts to help get you there.

Balanced vs. Unbalanced

Balanced Feedline:

- A balanced feedline consists of two conductors, with equal currents flowing in opposite directions.
- This symmetry ensures that the electromagnetic fields around the feedline cancel out, reducing radiation and interference.
- Examples: Ladder line or twin-lead are balanced feedlines.

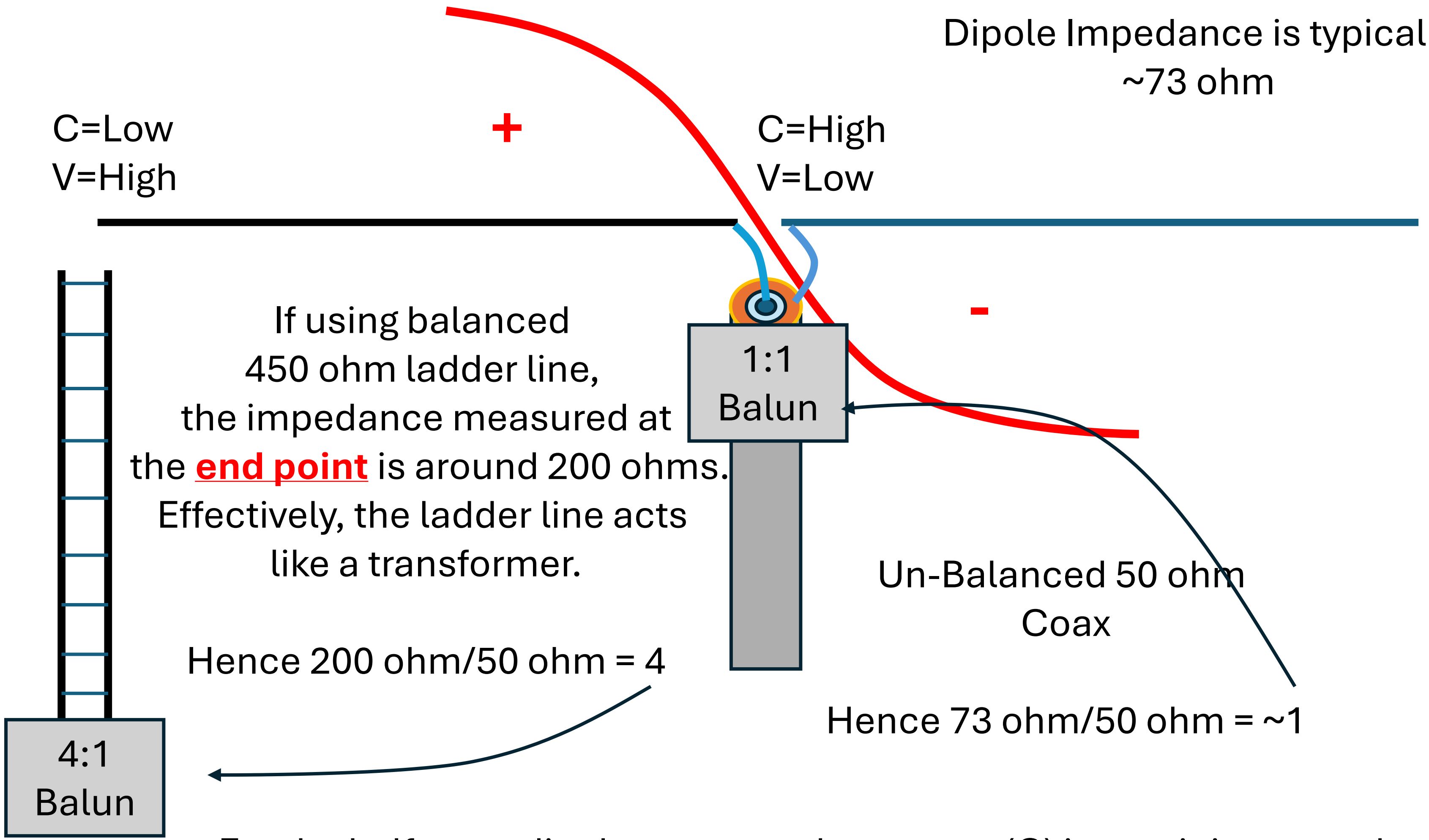
Balanced vs. Unbalanced

Unbalanced Feedline:

- An unbalanced feedline has one conductor carrying current, while the other is usually connected to ground.
- The currents and voltages are not symmetric.
- Examples: Coaxial cable is the most common unbalanced feedline for unbalanced antennas

Single Band Dipole

Example is ½ wave dipole

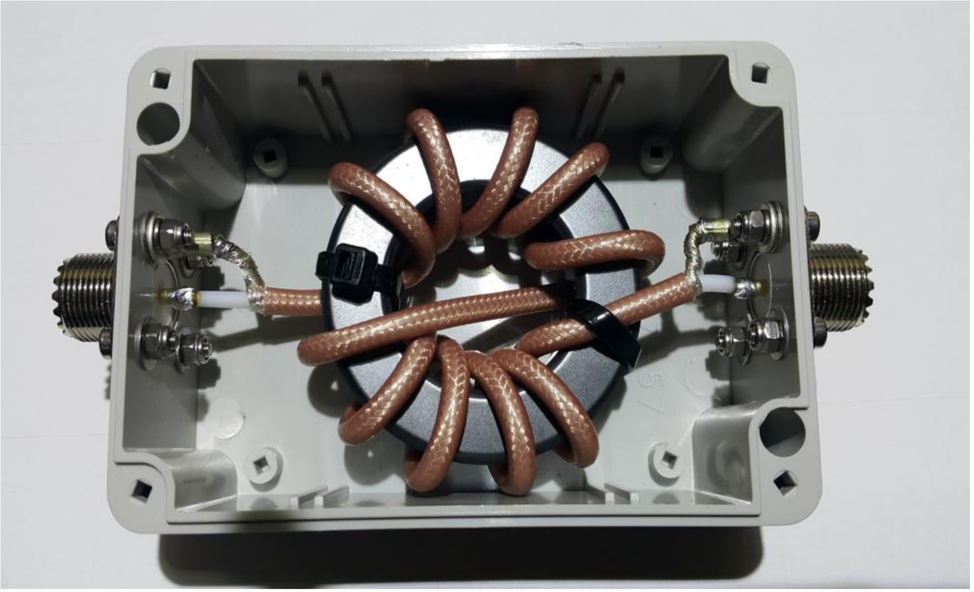


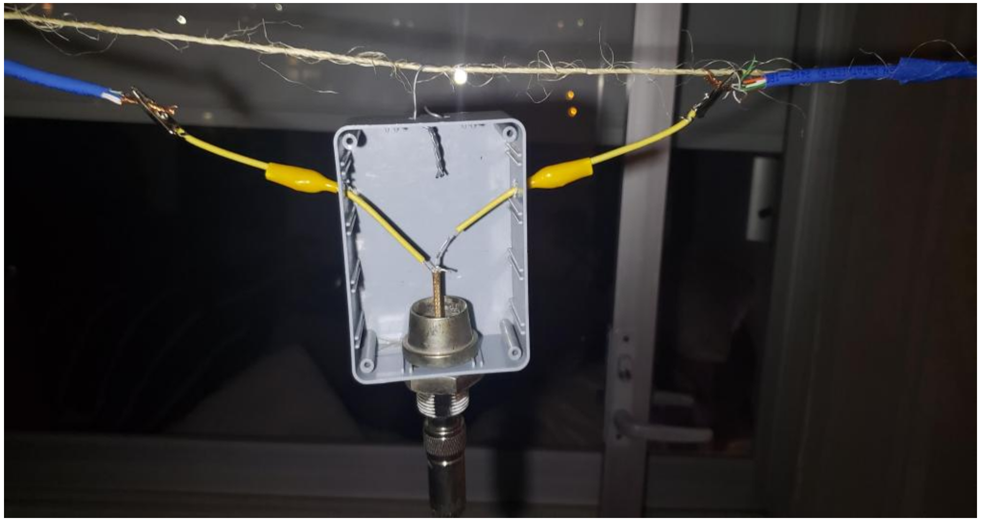
For the half wave dipole antenna, the current (C) is at minimum at the ends and maximum in the middle where the feed is applied. Voltage (V) is the opposite of current.

Dipole Antenna

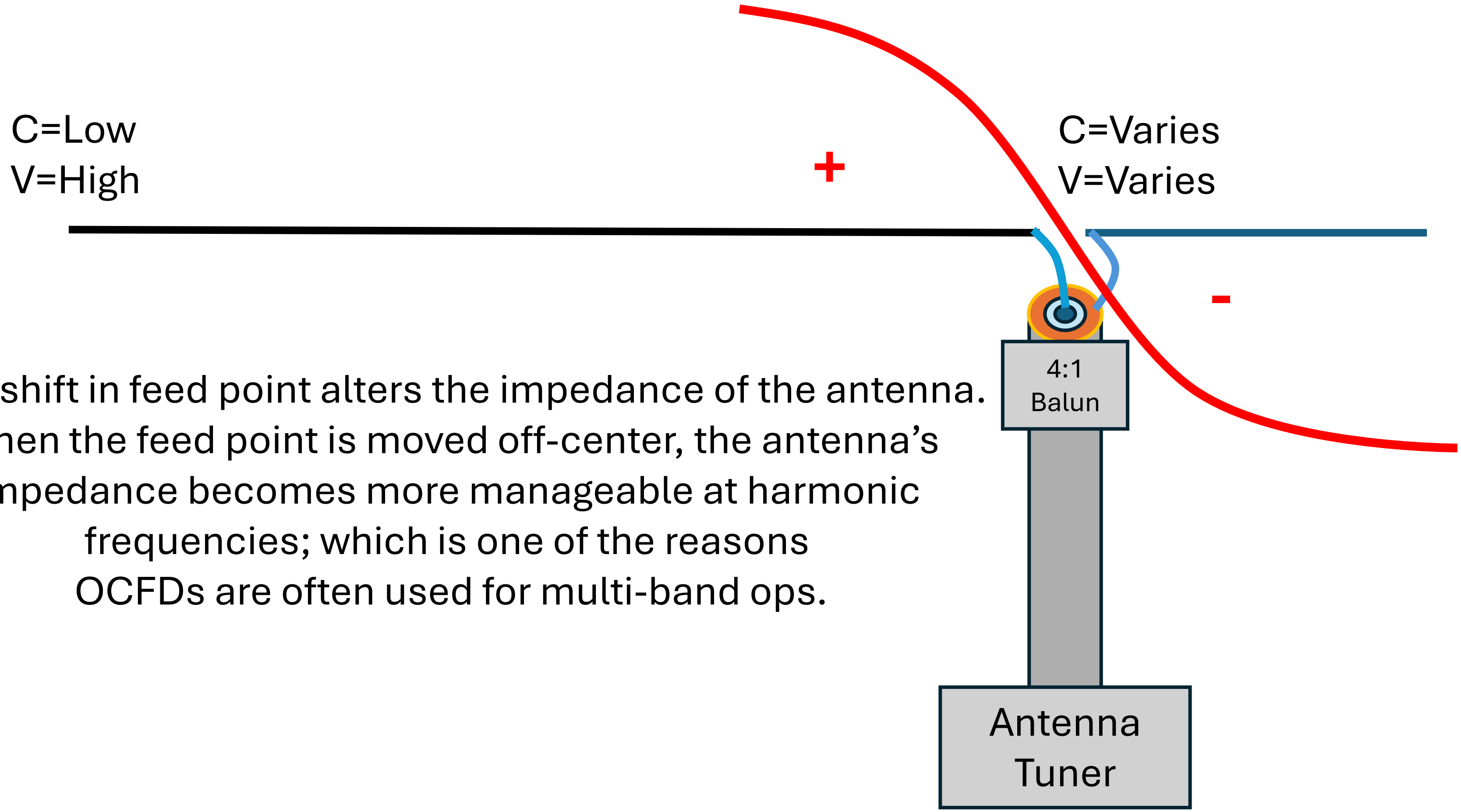
- **Structure**: Two symmetrical elements with a central feed point, and typically half a wavelength long.
- **Characteristics**:
  - Balanced current distribution.
  - Broadside radiation pattern.
- **Advantages**:
  - Simple and efficient.
  - Easy to construct.
- **Drawbacks**:
  - Requires balanced feeding.
  - Needs space for deployment.
- **Applications**: Common in amateur radio and straightforward setups.

Dipole Connections and 1:1 BALUN





Off-Center Fed Dipole



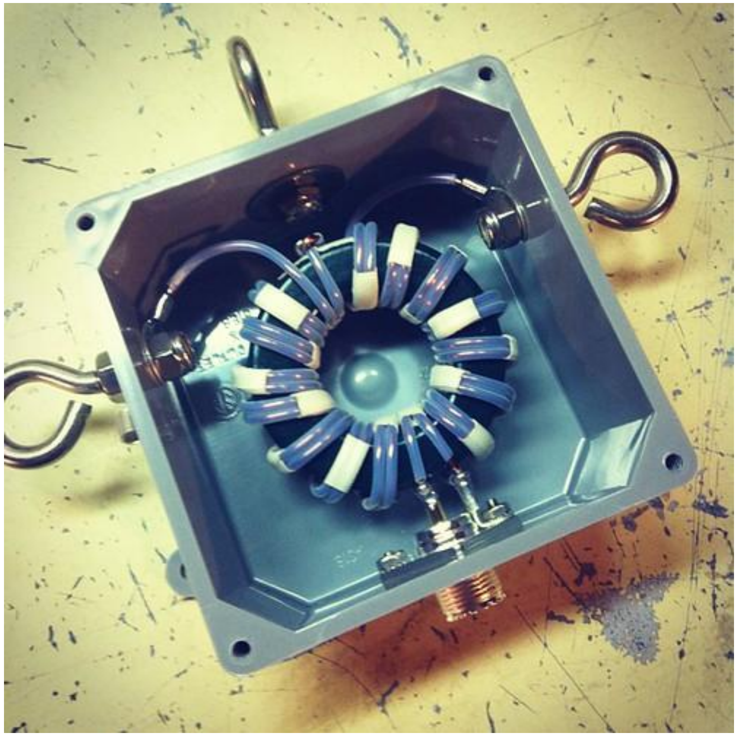
This shift in feed point alters the impedance of the antenna. When the feed point is moved off-center, the antenna's impedance becomes more manageable at harmonic frequencies; which is one of the reasons OCFDs are often used for multi-band ops.

For the OC-fed half wave dipole antenna, the current (C) is still minimum at the Ends, but varies in the middle where the feed is applied depending on shift point. Voltage (V) is still the opposite of current but also varies with the shift point.

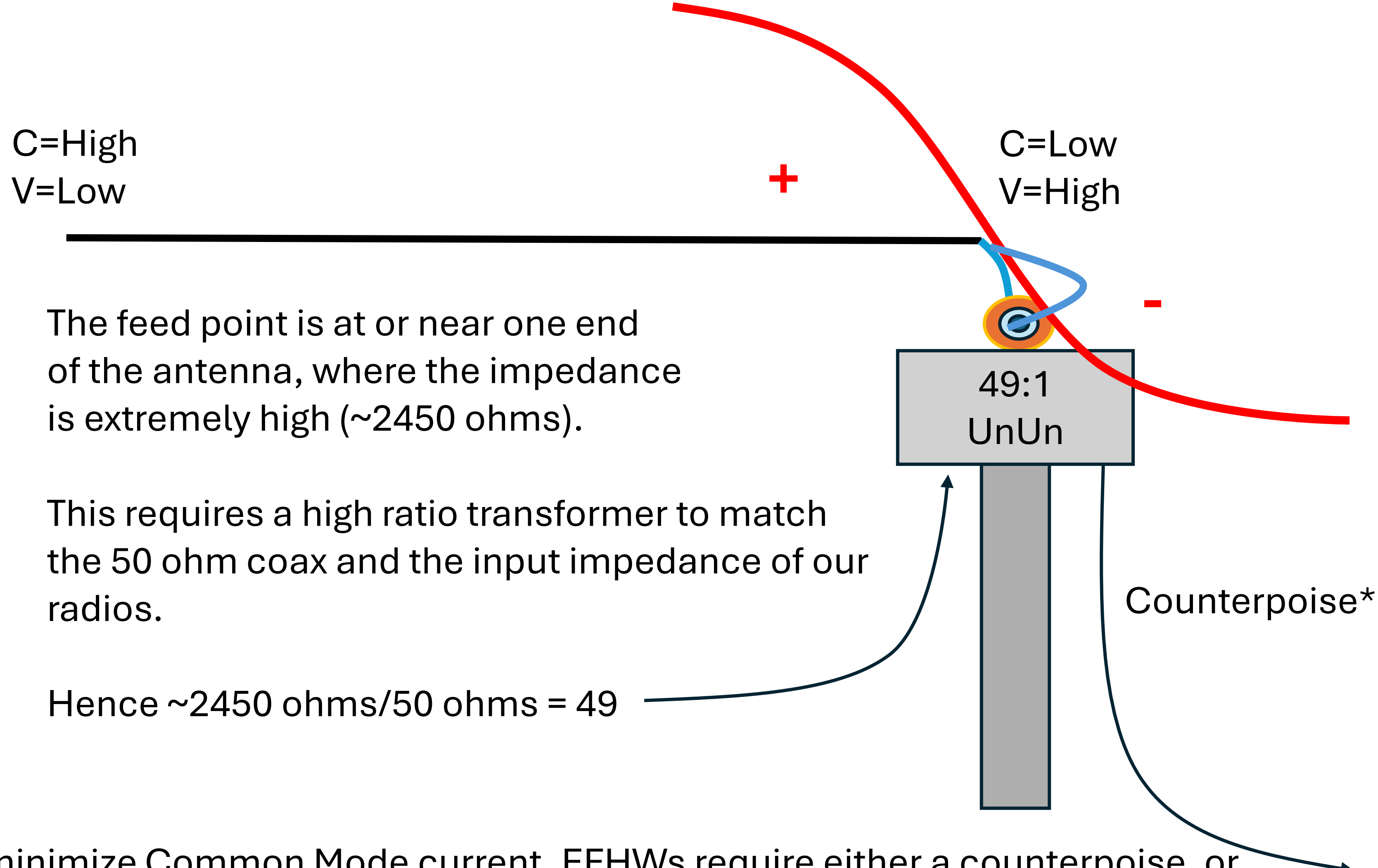
Off-Center Fed Dipole Antenna

- **Structure**: Similar to the dipole but with an off-center feed point.
- **Characteristics**:
  - Unequal-length segments.
  - Supports multi-band operation.
- **Advantages**:
  - Flexible for different frequencies.
  - Space-saving for non-symmetrical installations.
- **Drawbacks**:
  - Requires impedance matching.
  - Slightly less efficient than the dipole.
- **Applications**: Useful for HF communication and space-limited setups.

OCFD – 4:1 BALUN and/or Ant. Tuner



End-Fed Half Wave



The feed point is at or near one end of the antenna, where the impedance is extremely high (~2450 ohms).

This requires a high ratio transformer to match the 50 ohm coax and the input impedance of our radios.

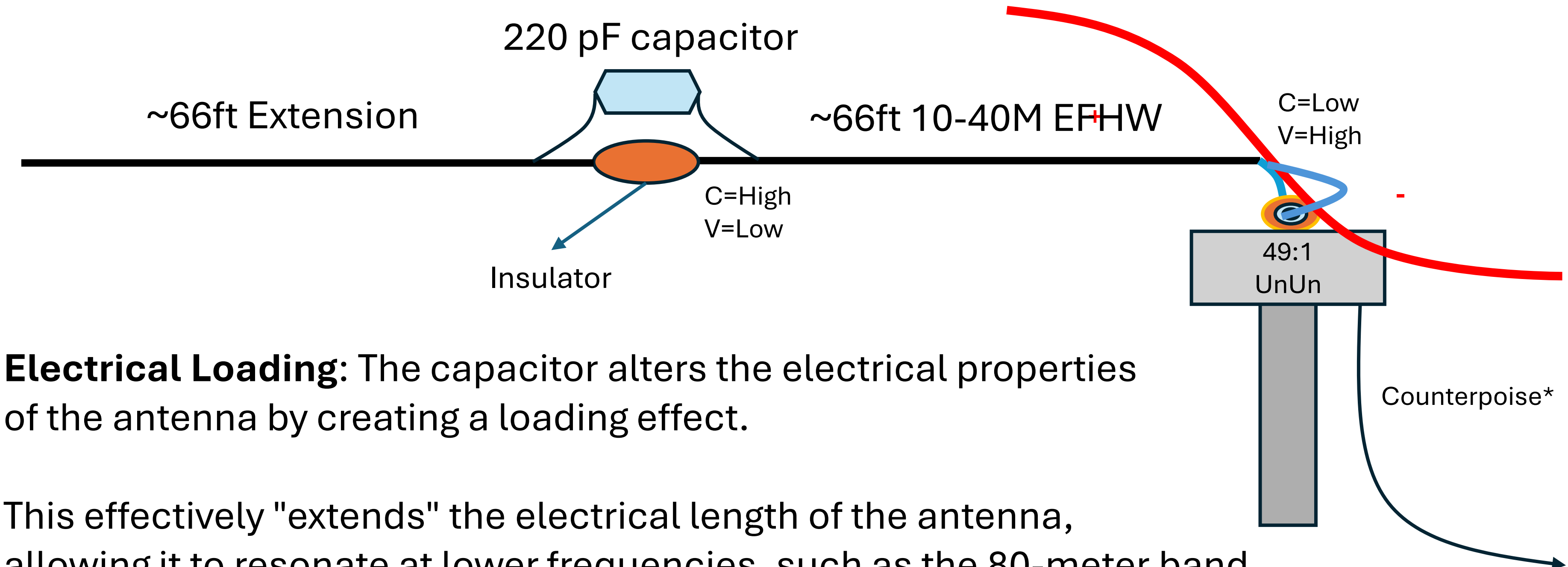
Hence ~2450 ohms/50 ohms = 49

*To minimize Common Mode current, EFHWs require either a counterpoise, or at least 50ft of loose coax to mitigate the return interference.

The 10-40M EFHW Harmonics

1.	**Primary Harmonic**	**=**	**7MHz**	**(40M Band)**
2.	**Second Harmonic**	**=**	**7MHz x 2 = 14MHz**	**(20M Band)**
3.	**Third Harmonic**	**=**	**7MHz x 3 = 21 MHz**	**(15M Band)**
4.	**Fourth Harmonic**	**=**	**7MHz x 4 = 28 MHz**	**(10M Band)**

Working 80M on an EFHW



Electrical Loading: The capacitor alters the electrical properties of the antenna by creating a loading effect.

This effectively "extends" the electrical length of the antenna, allowing it to resonate at lower frequencies, such as the 80-meter band (around 3.5 MHz), without physically increasing its size.

What the 220pf Capacitor Does

Tuned Resonance: When a capacitor is added between the two sections, it creates a resonant LC (inductor-capacitor) circuit.

The value of the capacitor is carefully chosen so that the antenna becomes resonant at the 80-meter band frequency. This allows the antenna to efficiently radiate at this lower frequency.

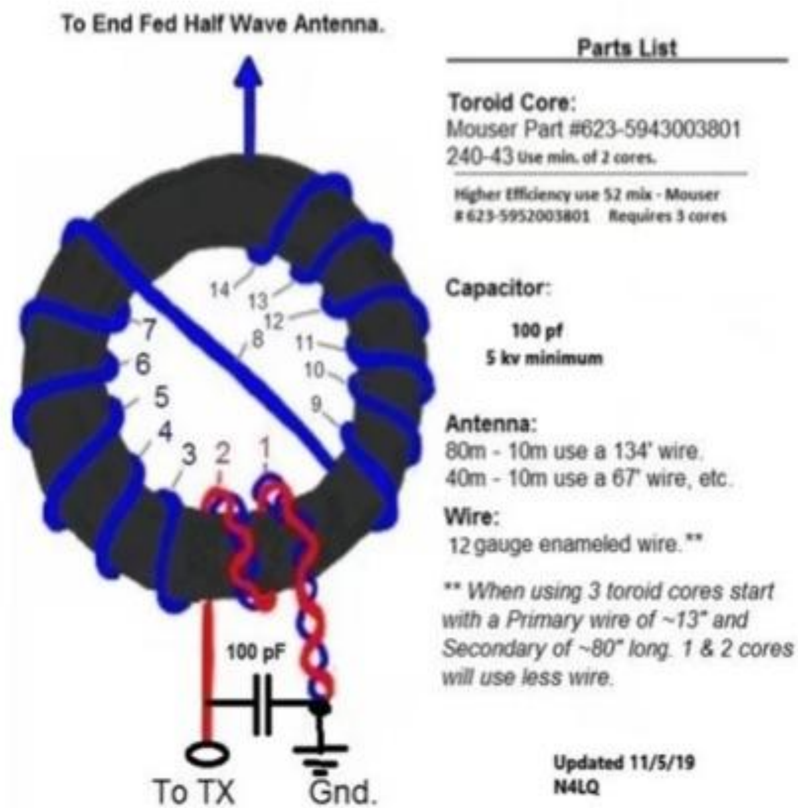
Center Loading: Adding the capacitor in the center provides balanced loading to the antenna.

This reduces the physical wire length needed to achieve resonance at the 80-meter band and optimizes the radiation pattern and efficiency.

End-Fed Half Wave Antenna

- **Structure**: A single conductor fed at one end, with a matching transformer for proper feeding.
- **Characteristics**:
  - High impedance at feed point.
  - Operates on multiple harmonics.
- **Advantages**:
  - Compact and portable.
  - Minimal ground radials required.
- **Drawbacks**:
  - Matching unit necessary.
  - Prone to common-mode currents.
- **Applications**: Ideal for portable setups and constrained spaces.

EFHW – 49:1 UNUN



Technical Overview

Feature	Dipole	Off-Center Fed Dipole	EFHW
Feed Point	Center	Off-center	End-fed
Impedance	Balanced (~50 ohms)	Varies (i.e. ~200 ohms)	High (~2500 ohms)
Design	Symmetrical	Asymmetrical	Single conductor
Flexibility	Single band	Multi-band capable	Multi-band capable
Space Needs	Full-length space	Flexible	Minimal
Efficiency	High	Moderate	Variable

Typical Applications

Applications

- **Dipole**: Simple setups, amateur radio, single-band communication.
- **Off-Center Fed Dipole**: Multi-band HF communication, limited space installations.
- **EFHW**: Portable or stealth setups, quick deployment.

A word about tuning your wire antennas

If you follow this formula for cutting a 10-40M EFHW wire .....

468 / 7.15MHz = 65.45’ (Rounded to 66’)

......you will be disappointed. You need at least an extra 6” on each end to fasten the insulators. Start with a longer wire (i.e. 67’) and cut it to size to get the lowest SWR at the desired 7.15 MHz sweet spot

Remember the mnemonic “**R**ise **UP** and **Run** **DOWN**”

R-UP = the reactance of the antenna is **highly inductive** (positive reactance), it indicates that the antenna is **too long**, and you would need to **shorten the wire**

R-DOWN = if the reactance is **highly capacitive** (negative reactance), it indicates that the antenna is **too short**, and you would need to **lengthen the wire**.

Conclusion

- Dipole: Efficient, simple, space-requiring.
- Off-Center Fed Dipole: Multi-band, flexible, moderately efficient.
- EFHW: Compact, versatile, requires impedance matching.

Thank You!
&
Questions