THEORY AND CONSTRUCTION OF A VHF 2M SLIM JIM ANTENNA

BY

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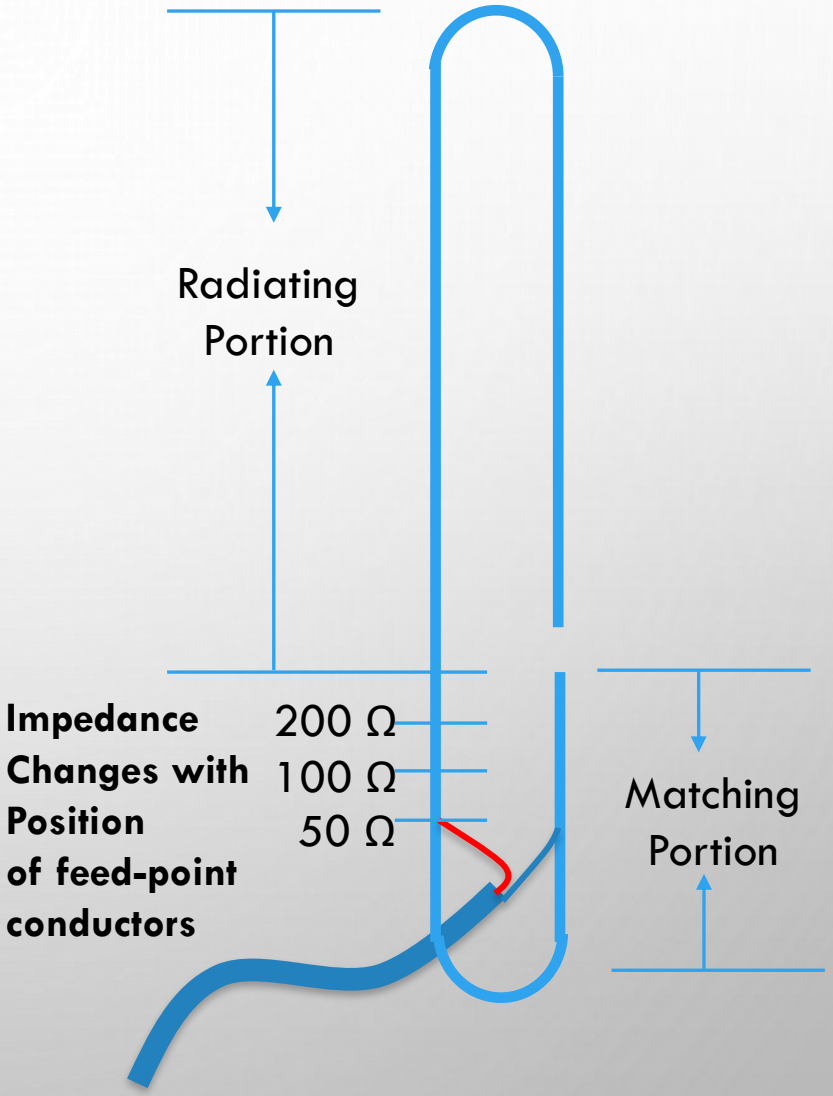
W2AUS

WHAT IS A SLIM JIM ANTENNA?

- A SLIM JIM IS A VERTICALLY POLARIZED OMNIDIRECTIONAL ANTENNA DERIVED FROM THE J-POLE.
- CONSTRUCTED FROM A FOLDED HALF-WAVE **DIPOLE*** WITH AN INTEGRATED QUARTER-WAVE MATCHING STUB.
- "**J** **I**NTEGRATED **M**ATCHING" (JIM) GIVES IT THE NAME SLIM JIM.
- PROVIDES A LOW-ANGLE RADIATION PATTERN IDEAL FOR TERRESTRIAL VHF/UHF COMMUNICATION

ANATOMY OF A SLIM-JIM ANTENNA

- THE SLIM-JIM IS ESSENTIALLY AN END-FED *DIPOLE** WITHOUT THE NEED FOR A COUNTERPOISE AND IT HAS ITS OWN 50 Ω IMPEDANCE MATCHING CIRCUIT
- THE STUB ACTS LIKE AN IMPEDANCE TRANSFORMER BETWEEN THE RADIATOR AND COAX FEEDLINE.
- THIS ENABLES EFFICIENT ENERGY COUPLING WITH MINIMAL MISMATCH.



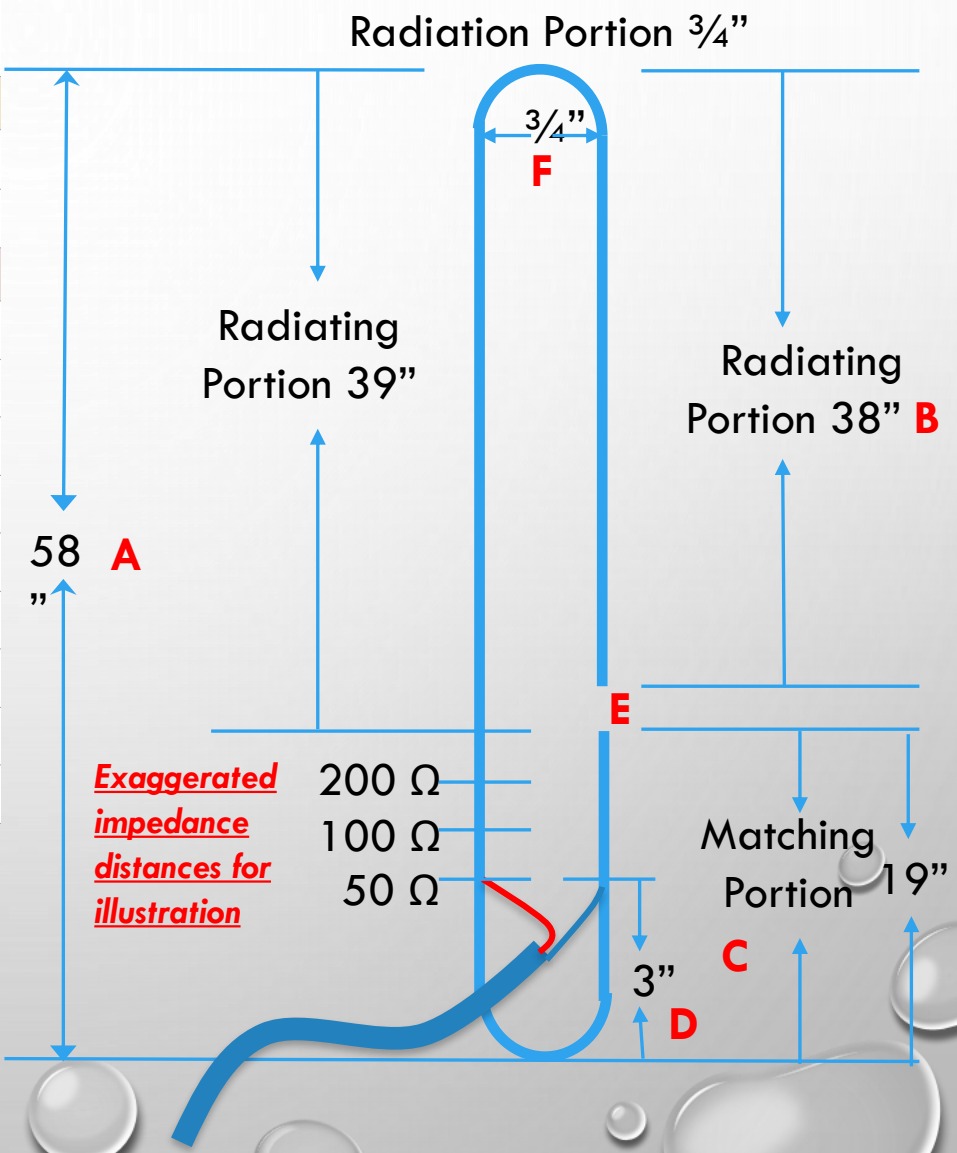
* **NOTE:** WHEN YOU LOOK AT THE **ELECTRICAL BEHAVIOR AND FEEDPOINT DYNAMICS,** THE **SLIM JIM** SHARES MORE DNA WITH **OFF-CENTER-FED DIPOLES (OCFD)** AND **RANDOM WIRE END-FEDS** AND WITH CLASSIC **END-FED HALF-WAVE DIPOLES (EFHW).**

Slim Jim Structure Math

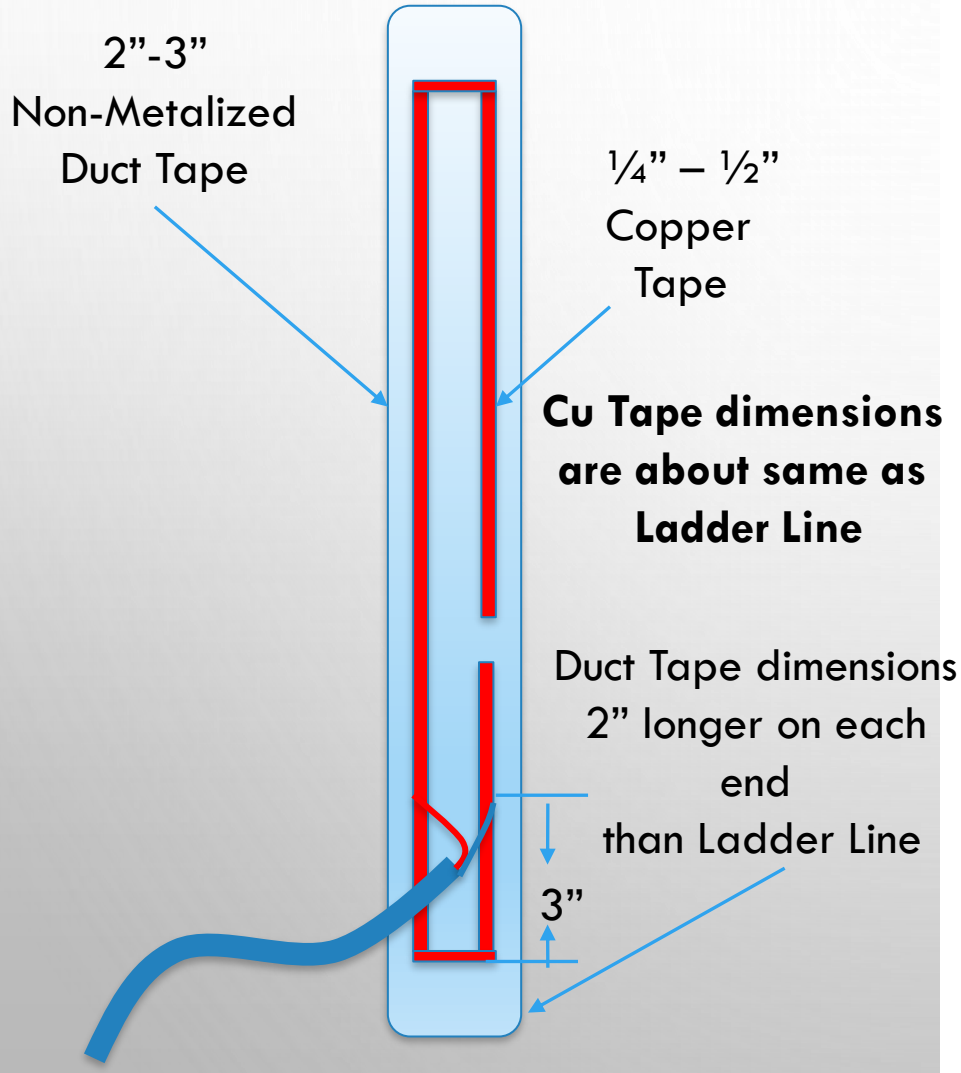
Slim Jim and J Pole calculator

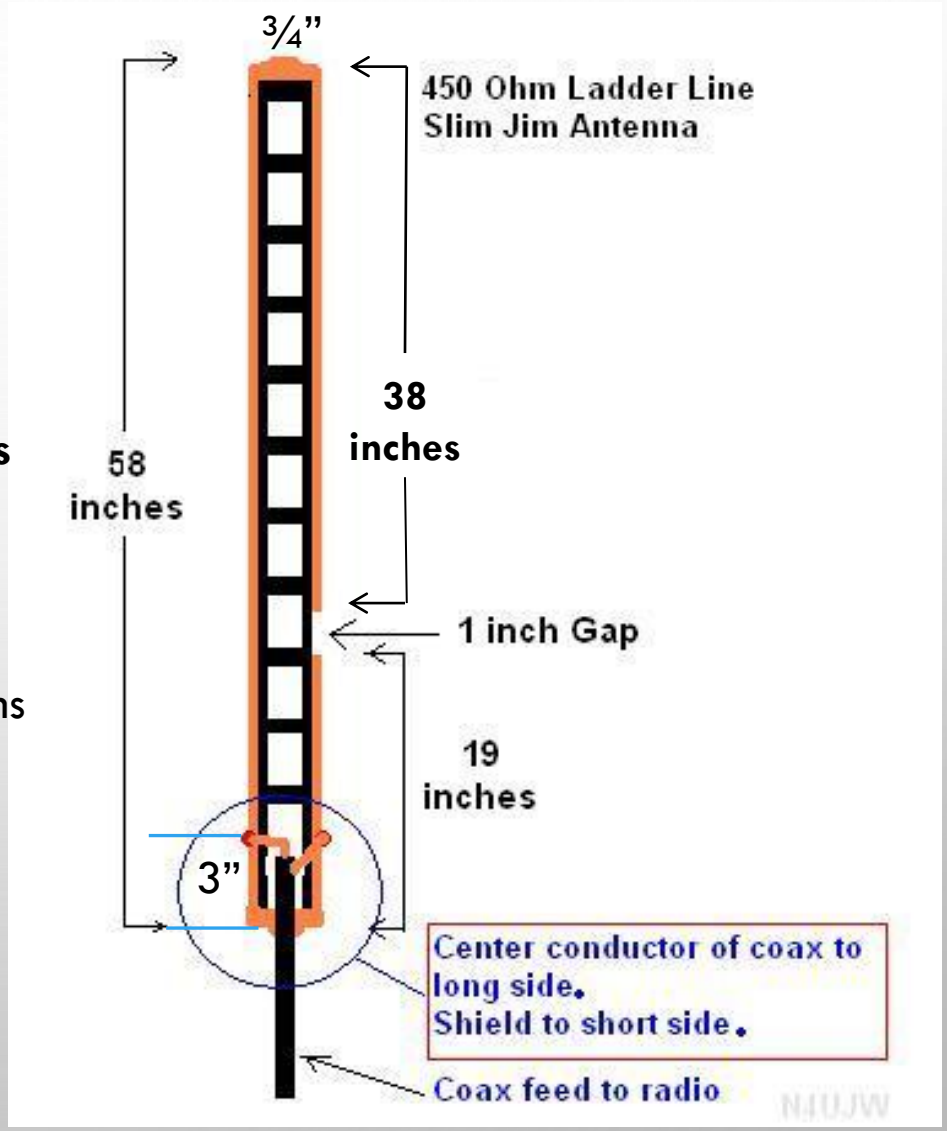
Slim Jim / J Pole antenna calculator.	
Frequency	146 MHz
Velocity Factor (see text*)	0.96 vf
Calculate my Slim Jim / J Pole!	
Actual wavelength	2.05 metres
Wavelength considering velocity factor	1.97 metres
A. Overall length (λ*0.75)*vf (plus gap for Slim Jim)	147.9 cm (J Pole)
	150.0 cm (Slim Jim)
B. Half wave radiator section (λ/2)*vf	98.6 cm
C. Quarter wave matching section (λ/4)*vf	49.3 cm
D. 50Ω feed point. Adjust for 1:1 SWR. (λ/40)*vf	4.9 cm
E. Gap (λ/100)	2.1 cm
F. Spacing - not critical	4.5 cm

[M0UKD Antenna Calculator]



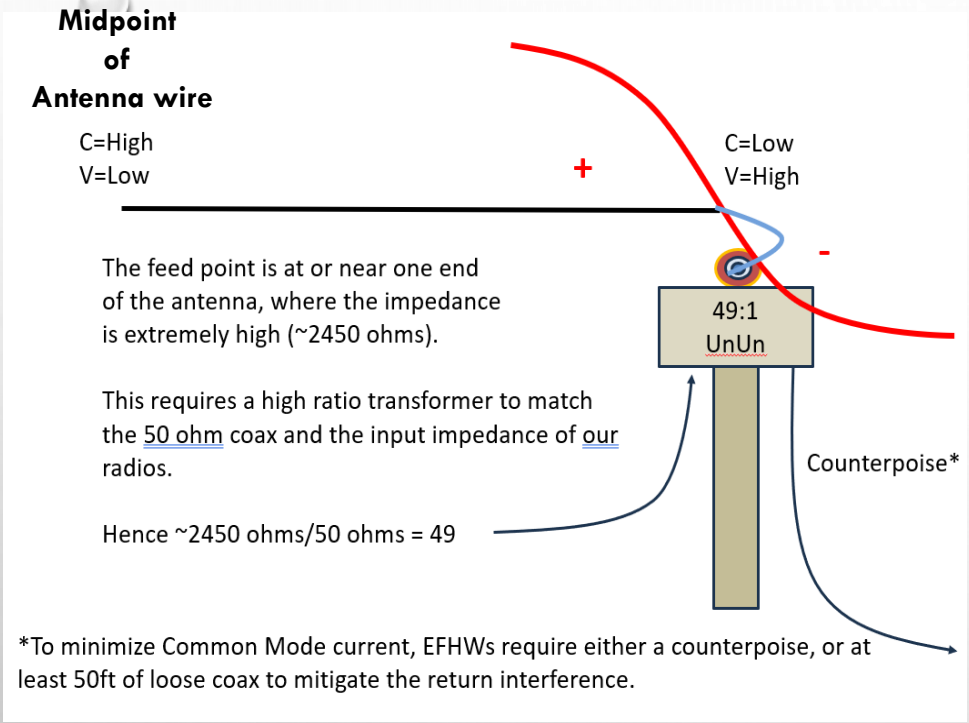
SLIM JIM: LADDER LINE OR CU TAPE

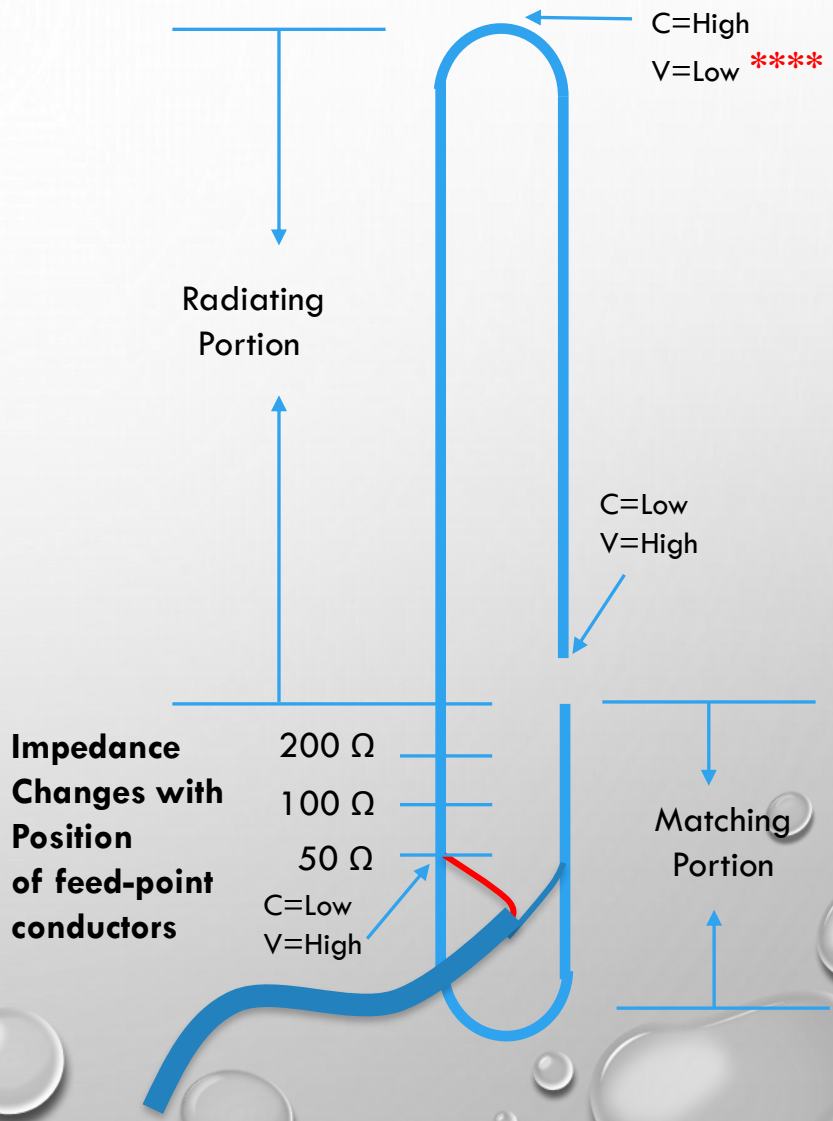




FOLLOWS THE END-FED CONCEPT

(THIS IS THE ***VOLTAGE/CURRENT RATIO***)





**** Note: this is a λ/2 radiator, hence the top bend of the physical antenna is approx. the center point of the antenna.

THE MATCHING STUB CONCEPT

- WE CAN USE THE **VOLTAGE/CURRENT RATIO** TO OUR ADVANTAGE IN TUNING THE ANTENNA
  - THE AC SIGNAL IS APPLIED AT THE FEEDPOINT — SAME SOURCE, SAME FREQUENCY.
  - AT ANY INSTANT IN TIME, THE VOLTAGE AND CURRENT AT THE FEEDPOINT JUNCTION ARE THE SAME FOR BOTH STUB AND RADIATOR (THEY'RE PHYSICALLY CONNECTED).
  - BUT HOW THAT ENERGY PROPAGATES UP EACH ELEMENT DIFFERS:
    - THE RADIATOR SETS UP A ½-WAVE STANDING WAVE.
    - THE STUB SETS UP A ¼-WAVE STANDING WAVE WITH OPPOSITE SLOPE (INVERSE) IN THE VOLTAGE CURRENT RATIO

“THE FOLD” IS THE MAGIC

….IT BEHAVES MUCH LIKE A COLLINEAR ANTENNA!

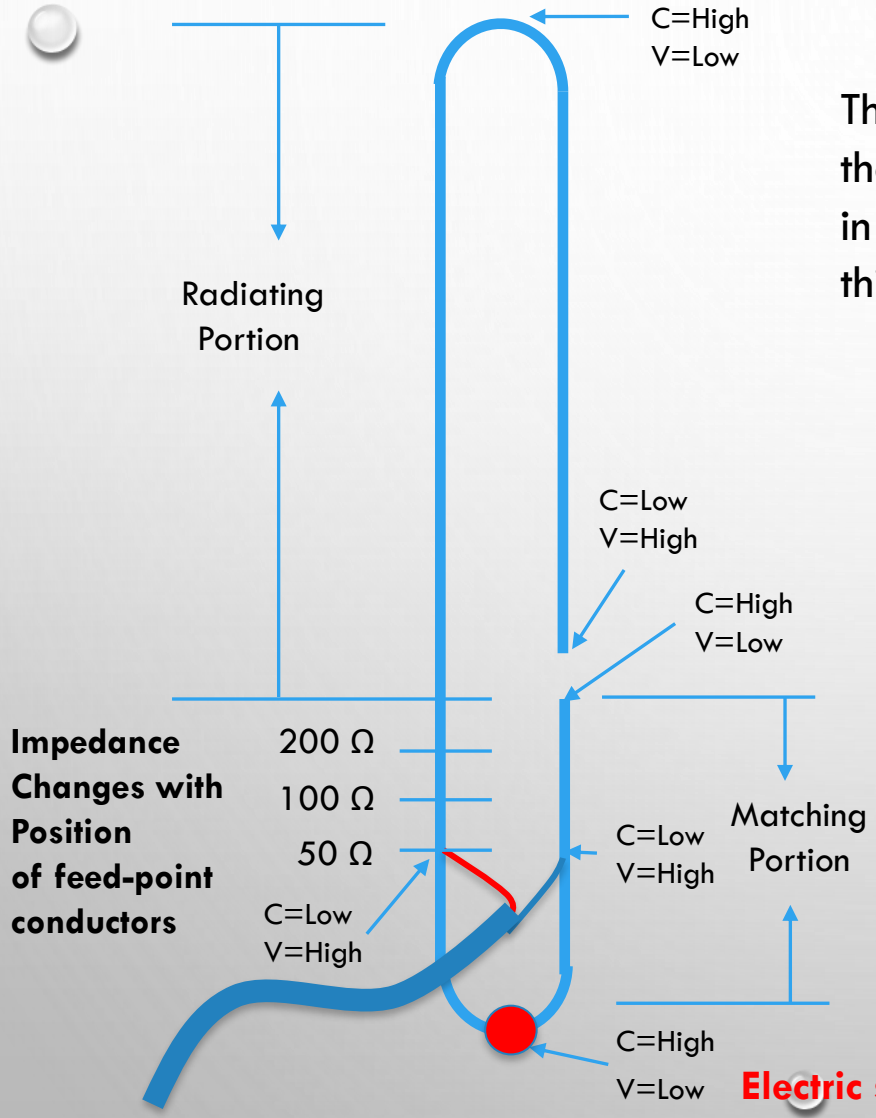
- THE SLIM JIM’S FOLDED HALF-WAVE RADIATOR IS NOT TWO SEPARATE RADIATORS — IT’S A SINGLE CONDUCTOR PATH FOLDED BACK ON ITSELF.
- CURRENT FLOWS UP ONE LEG, THROUGH THE TOP, AND DOWN THE OTHER — FORMING A CONTINUOUS ELECTRICAL PATH.
- THIS FOLDING CREATES A **FULL-WAVE** RADIATOR PHYSICALLY, BUT IT BEHAVES LIKE A **HALF-WAVE** RADIATOR ELECTRICALLY.
- **WHY FOLD IT?**
- THE FOLD LOWERS THE TAKEOFF ANGLE OF RADIATION — IMPROVING HORIZONTAL COVERAGE.
- IT ALLOWS THE ANTENNA TO BE FED FROM THE BOTTOM, LIKE A J-POLE, BUT WITH BETTER GAIN AND BROADER PATTERN.
- THE TWO CONNECTED LEGS ACT LIKE A **COLLINEAR RADIATOR**, ENHANCING PERFORMANCE SLIGHTLY OVER THE J-POLE.
- **COLLINEAR ANTENNA** IS ONE WHERE MULTIPLE RADIATING ELEMENTS ARE ARRANGED IN A STRAIGHT LINE (CO-LINEAR) — TYPICALLY VERTICALLY — AND FED IN PHASE TO REINFORCE RADIATION IN THE HORIZONTAL PLANE.

CAPACITANCE! IS WHY THE SLIM-JIM FOLDING DESIGN WORKS SO WELL

- THE TWO PARALLEL (COLLINEAR) LEGS OF THE FOLDED FULL-WAVE RADIATOR ACT LIKE A TRANSMISSION LINE, INTRODUCING MUTUAL CAPACITANCE.
  - THIS CAPACITANCE SOFTENS THE IMPEDANCE CURVE NEAR RESONANCE:
  - THE TRANSITION INTO RESONANCE IS LESS ABRUPT
  - THE SWR CURVE FLATTENS, IMPROVING BANDWIDTH
  - THE ANTENNA IS LESS SENSITIVE TO SMALL CHANGES IN FREQUENCY OR ENVIRONMENT
- That's why resonance tends to be **sharper** and **narrower** in J-Poles

  *** THIS MAKES SENSE INTUITIVELY BECAUSE WE USE CAPACITORS TO SMOOTH OUT ELECTRICAL SIGNALS – HENCE CAPACITANCE IS USED FOR SMOOTHING THE VOLTAGE/CURRENT RATIO RAMP-UP SIGNAL (I.E., WE SMOOTH OUT THE ELECTRICAL PRESSURE BUILD-UP IN THE ANTENNA)

STUB VOLTAGE/CURRENT RATIO IS ELECTRICALLY INVERSE OF RADIATOR

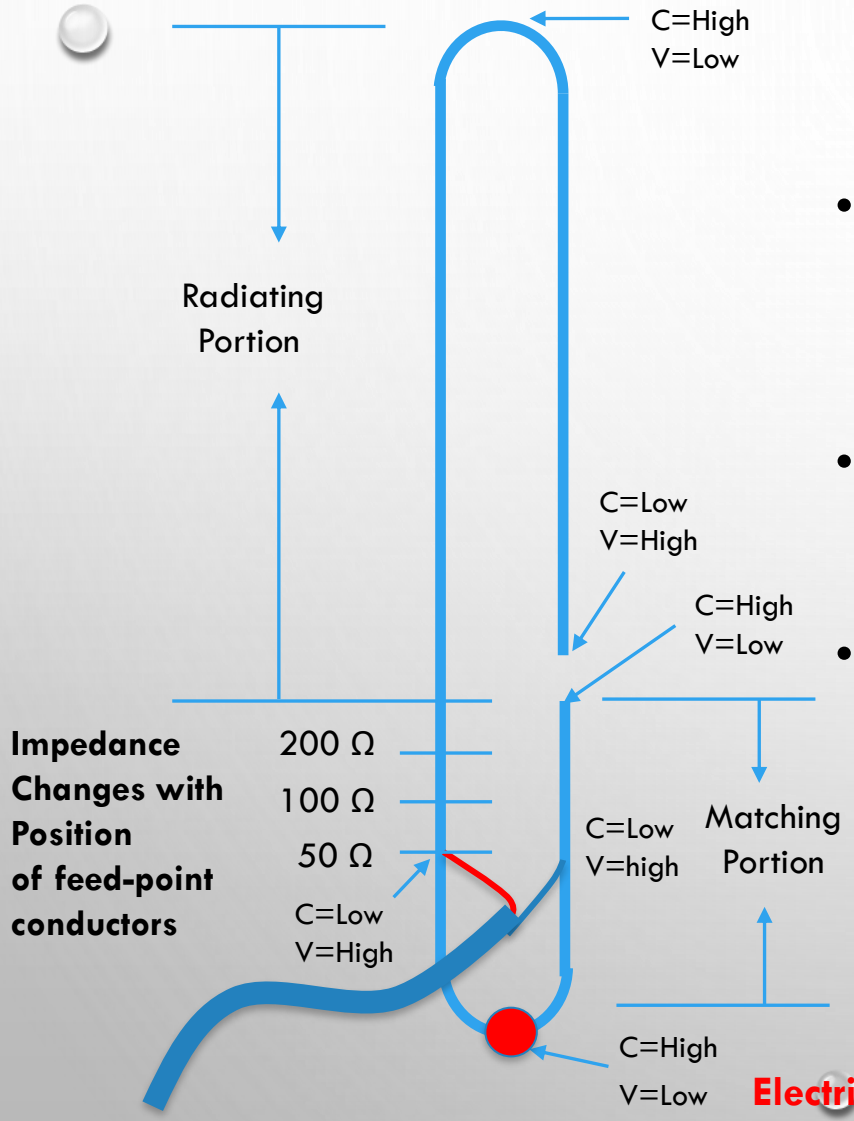


The **λ/4 matching stub** in a Slim Jim or J-Pole is the **electrical inverse** of the **λ/2 radiator** in terms of **voltage and current distribution;** this provides the **Matching Energy** to the radiator.

Why is that,
and how does that help
us tune the antenna
to ~50Ω impedance?

…….Because we can use the stub voltage/current ratio to manipulate the impedance in the radiator

LAYMAN'S TERMS



- Because you can vary the feedpoint on the stub (at around 50Ω, you don't need to apply a big electrical "pressure" (voltage) to get energy (current) into the antenna.
- That's the point where the impedance closely matches the radio, so **current flows efficiently** and the antenna radiates well.
- The **high voltage still exists at the top of the radiator,** but your radio doesn't have to supply it directly.

SLIM-JIM ELECTRICAL AND PHYSICAL PROPERTIES

- THE HALF-WAVE RADIATOR GIVES YOU THE GAIN AND RESONANCE OF A DIPOLE.
- THE QUARTER-WAVE STUB LETS YOU FEED IT FROM THE END WITH 50Ω COAX — NO BALUN NEEDED.
- THE FOLDED GEOMETRY IMPROVES BANDWIDTH AND LOWERS THE TAKEOFF ANGLE, MAKING IT IDEAL FOR TERRESTRIAL VHF COMMS.

RELATIONSHIP TO THE J-POLE

- SLIM JIM SHARES THE SAME QUARTER-WAVE MATCHING STUB AS A REGULAR J-POLE.
- ADDS A FOLDED ELEMENT FOR SMOOTHER IMPEDANCE AND LOWER RADIATION ANGLE.
- BOTH USE A 50Ω FEED TAP ALONG THE STUB.
- SLIM JIM OFTEN YIELDS ~1–2 DB MORE GAIN AT LOW ANGLES.

HIGH-LEVEL COMPARISON

Feature	J-Pole (End-Fed Dipole)	Slim Jim (End-Fed Radiator)
Radiator Type	Straight λ/2	Folded λ/2
Feedpoint Location	Stub tap near bottom	Stub tap near bottom
Impedance Transformation	Sharp via stub	Smoother via folded geometry
Radiation Pattern	Slight downward tilt	Lower angle, broader lobe
Electrical Analogy	End-fed dipole	End-fed long wire

HIGH LEVEL COMPARISON

Feature	J-Pole Antenna	Slim Jim Antenna
Radiator Shape	Straight vertical (λ/2)	Folded "U" shape (λ/2 folded)
Radiator Electrical Length	λ/2 (~38–40 inches)	λ/2 (~38–40 inches total folded)
Radiator Physical Height	~38–40 inches	~60+ inches (due to fold)
Matching Stub (λ/4)	~19–20 inches (parallel stub)	~19–20 inches (vertical leg of "U")
Feedpoint Tap Location	~1–3 inches above stub short	~1–3 inches above stub short
Gap Between Stub & Radiator	~1 inch (non-radiating)	~1 inch (non-radiating)
Total Physical Height	~58–60 inches	~78–80 inches

"ANTENNA THEORY" VS. PRACTICALITY

- IN THEORY WE SHOULD TAP THE FEEDPOINT AT 50Ω IMPEDANCE, BUT THE REALITY IS THAT WE WILL RARELY GET THE LOWEST SWR MEASUREMENT ALONG WITH A PERFECT 50Ω IMPEDANCE MATCH.
- AS DIY OPERATORS/BUILDERS, WE STRIVE TO FIND A BALANCE BETWEEN DESIGN AND FUNCTION. THEREFORE, A LOW SWR AND A HIGHER THAN 50Ω IMPEDANCE IS PERFECTLY ACCEPTABLE AND IS IN FACT A VERY COMMON CHARACTERISTIC OF THESE HOMEBUILT DESIGNS.
- **BOTTOM LINE – DON'T DRIVE YOURSELF CRAZY CHASING A PERFECT IMPEDANCE MATCH WITH THE LOWEST SWR. - JUST BUILD IT, YOUR RADIO WILL HARDLY NOTICE.**

COPPER TAPE SLIM-JIM BUILDING STEPS

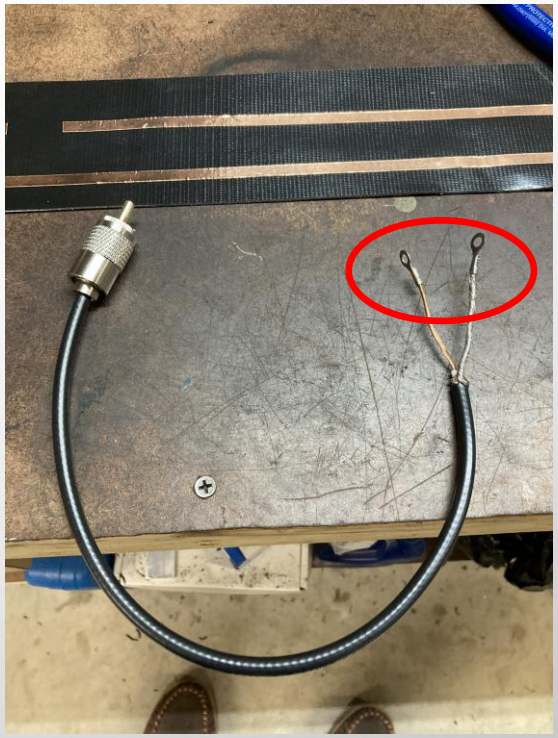
THE BUILD: COPPER TAPE

Step 1: Layout the backing tape about 64-66” and secure it on a flat surface

THE BUILD: COPPER TAPE

Step 2: Layout the copper tape according to precise dimensions.

Make a PL-259 feedline tail out of coax
*Notice the two ring connectors on the feed-points (IMPORTANT)



THE BUILD: COPPER TAPE

Step 3: This is what the finished antenna should look like

THE BUILD: COPPER TAPE

Step 4: Use clothes pins or magnets to hold the feedline in place for tuning adjustment

THE BUILD: COPPER TAPE

Step 5: Permanently* attach feedline tail to antenna with small screws or pop rivets

*you could also just mark the resonant feedpoint with a paint marker and use strong neodymium magnets to temporarily hold the feedline in place (for ultra-portability)

LADDER LINE SLIM-JIM BUILDING STEPS

THE BUILD: LADDER LINE

Step 1: Layout the Ladder line tape about 59” and secure it on a flat surface;

…then expose the top end leads.

THE BUILD: LADDER LINE

Step 2: Fold over the top end leads and solder them

Identify and mark the 1” gap to create the 19” stub.

THE BUILD: LADDER LINE

Step 3: Cut the 1” stub gap, and reinforce the ladder line gap with tape to keep it from Sagging.

THE BUILD: LADDER LINE

Step 4: Expose ladder line wire between 2-1/2” and 3-1/2” up from the bottom

Expose, fold over and Solder bottom leads

THE BUILD: LADDER LINE

Step 5: Make a PL-259 feedline tail out of coax and temporarily attach to antenna feed point. ..notice **no** ring connectors required for his feedline Tail.

Tune the antenna and solder feedline to antenna

THE BUILD: LADDER LINE

Step 6: This what the finished antenna should look like, along with the feedline tails for each version.

SUMMARY

- SLIM JIM = FOLDED HALF-WAVE RADIATOR AND QUARTER-WAVE SHORTED STUB.
- STUB ACTS AS A TRANSMISSION-LINE TRANSFORMER FOR 50 Ω MATCHING.
- PROVIDES EFFICIENT, LOW-ANGLE, OMNIDIRECTIONAL RADIATION.
- EASY TO BUILD AND TUNE FOR VHF/UHF BANDS.

QUESTIONS AND DISCUSSION

- JOIN US THIS SATURDAY MORNING (9:00AM) AT THE FIGHTING CREEK PARK PAVILLION, WHERE WE WILL BUILD
  - 1) A 450Ω VHF LADDER LINE SLIM-JIM, AND
  - 2) A VHF COPPER TAPE SLIM-JIM
- WE'LL BUILD THE SLIM-JIMS IN SEQUENCE TO ALLOW PLENTY OF TIME FOR QUESTIONS, DISCUSSIONS, NOTES, AND PICTURES.