Building a 2m Slim Jim Backpack/Go bag Antenna

Rick Fletcher, W7YP
Flathead Valley Amateur Radio Club
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TOPICS

- What is a “Slim Jim” antenna?
- Construction materials
- Calculating dimensions to a center frequency
- Understanding the Calculator Sections
- Antenna characteristics and performance
  - Comparison to the J-pole antenna
- Trimming considerations
- Construction Video
- Why you should add a choke balun
- APRS version

What is a “Slim Jim” Antenna?

- Portable, end-fed, vertical 1/2λ folded dipole antenna
  - 1/2λ radiator is fed by 1/4λ stub
  - Folded geometry shares conductors
  - Overall length = 0.75λ x VF (Velocity Factor)
- Designed for the 144–148 MHz amateur band
  - Other VHF frequencies can also be supported
- A lightweight, roll-up, portable antenna which is a great emergency antenna and great for SOTA/POTA as a backpack antenna
- Low takeoff angle (essentially 0^o) makes it perfect for hitting distant repeaters and SOTA
  - Peak energy between 0^o and 10^o over ground, based on:
    - Height above ground
      - Low or with common mode issues: 10^o to 20^o
    - Soil characteristics

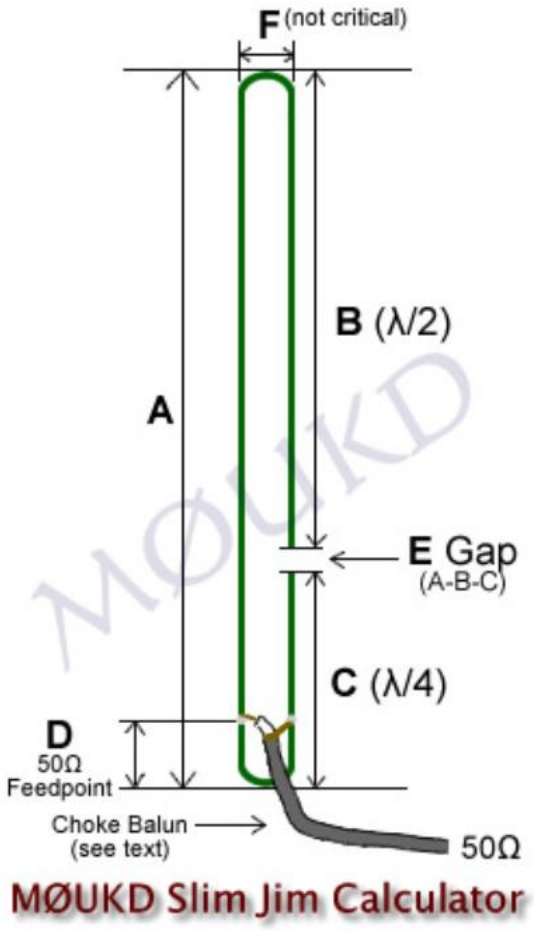
Construction Materials

- Typically made from 450Ω or 300Ω “ladder line”
- Makes construction easy and inexpensive
  - Makes antenna flexible and portable
  - 450Ω = $1.18/ft at DX Engineering
    - https://www.dxengineering.com/parts/dxe-ll450
  - 300Ω = $0.77/ft at DX Engineering
    - https://www.dxengineering.com/parts/dxe-ll300
- SO239 UHF connector (or a type of your choice)
- Some adhesive heat shrink tubing
  - Weatherproof coax connection to SO239 connector
  - Enclose the ends of the ladder line

M0UKD Slim Jim & J-pole Calculator

Slim Jim and J Pole calculator

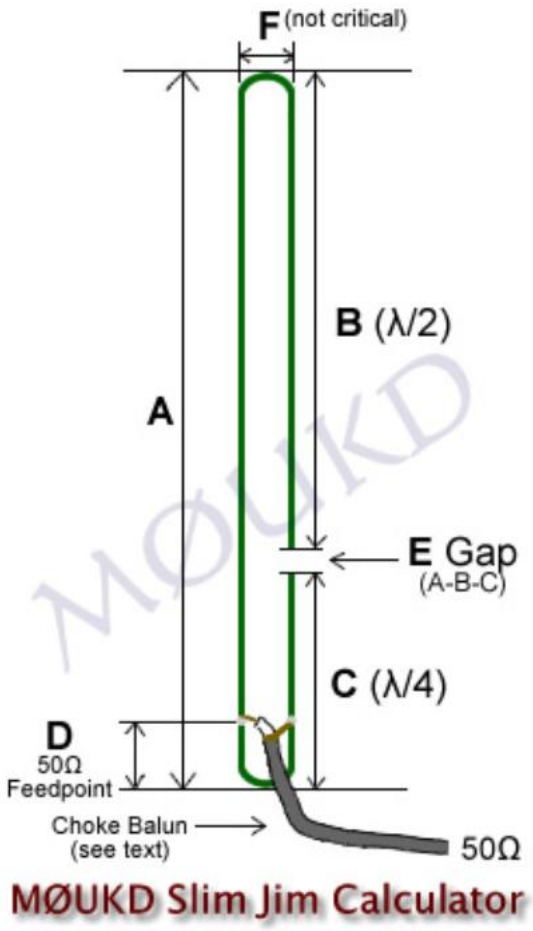
Slim Jim / J Pole antenna calculator.	
Frequency	146 MHz
Velocity Factor (see text*)	0.96 vf
Calculate my Slim Jim / J Pole!	
Actual wavelength	2.05 metres
Wavelength considering velocity factor	1.97 metres
A. Overall length (λ*0.75)*vf (plus gap for Slim Jim)	147.9 cm (J Pole) 150.0 cm (Slim Jim)
B. 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
Clear Form	



https://m0ukd.com/calculators/slim-jim-and-j-pole-calculator/

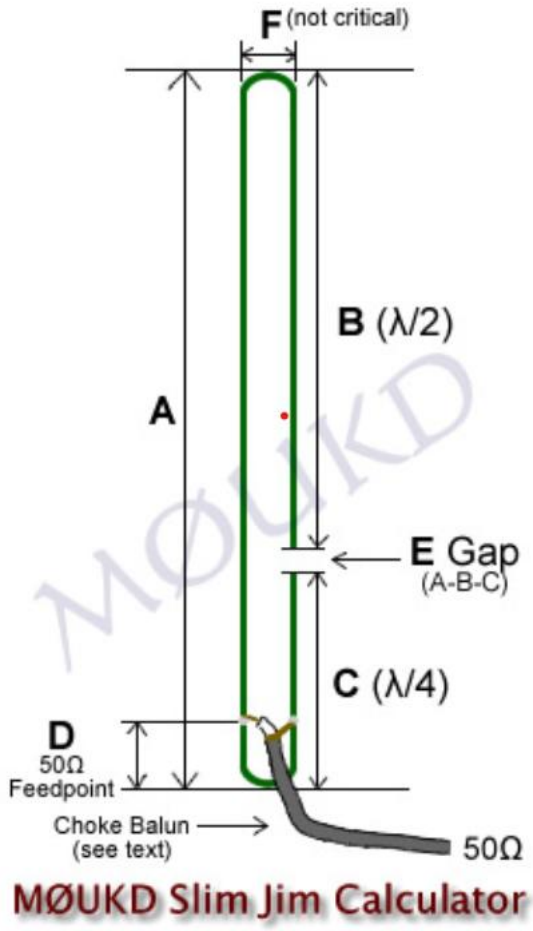
Understanding the Calculator Sections

- A = Overall length (0.75λ × VF)
  - B = 1/2λ radiator portion
  - C = 1/4λ matching stub
  - D = Approximate 50Ω feedpoint
  - E = Gap between radiator & stub
  - A ≈ B + C + E
- VF of 450Ω ladder line is typically 0.95 to 0.96
- VF of 300Ω twin lead is 0.80 to 0.90



146 MHz – 450Ω Ladder Line (VF 0.96)

- Overall length: 59.05 in
  - Radiator: 38.82 in
  - Stub: 19.41 in
  - Feedpoint: 1.93 in above short
  - Gap: 0.82 in
- Safe TX power: up to 150W
  - **If low SWR**
  - Low duty cycle may permit up to 300W
  - Maximum power depends upon ladder line used and construction
    - Wire gauge is important
      - Larger gauge = more power handling



146 MHz – 300Ω TV Twin Lead (VF 0.82)

- Overall length: 49.75 in
  - Radiator: 33.17 in
  - Stub: 16.58 in
  - Feedpoint: 1.66 in above short
  - Shorter because VF is lower
- Compared to 450Ω ladder line:
  - Higher loss
  - Higher dielectric loading
  - Harder to tune
  - It's the way to go if you want an ultracompact and truly slim Slim Jim
- Safe TX power: up to 50W, **IF low SWR**
  - Low duty cycle may permit up to 100W
  - Maximum power depends upon ladder line used and construction
    - Wire gauge is important
      - Larger gauge = more power handling
  - Why 450Ω handles more power:
    - More air dielectric
    - Wider spacing between conductors
    - Lower Loss
    - Less heating
    - Better voltage standoff
    - Larger breakdown margin at the gap and feedpoint

Head-to-head summary for a 2 m Slim Jim

Use this as the fast comparison slide in the updated reference deck.

Factor	300 Ω twin lead	450 Ω ladder line
Starting dimensions	Usually need a different cut table than 450 Ω designs; exact amount depends on the specific twin-lead style.	Many published VHF Slim Jim builds already assume this line or something very close to it.
Loss and efficiency	Typically higher dielectric involvement, so losses can be somewhat higher.	Usually lower loss because more of the field lives in air.
Outdoor durability	Can be fine, but ribbon-style products may age faster or trap moisture more easily.	Usually better for longer-term outdoor use if supported well.
Mechanical feel	More compact and easier to roll up or tape to a mast.	Stiffer and bulkier, but also more robust.
Power margin	Often lower, depending on conductor size and product style.	Often higher, especially in transmitting-grade window line.
Best use case	Portable, compact, experimental builds.	Default choice for a dependable outdoor 2 m Slim Jim.

300Ω Twin Lead Pros and Cons

Why you might choose it

Pros

- Compact and easy to coil for portable use
- Easy to cut, strip, and solder
- Can make a neat, lightweight antenna body
- Sometimes easier to source locally

Cons

- Published 450 Ω dimensions usually will not transfer directly
- Often more dielectric loading and a bit more loss
- Can be more sensitive to moisture, UV, or close mounting surfaces
- Some ribbon-style products are less rugged outdoors

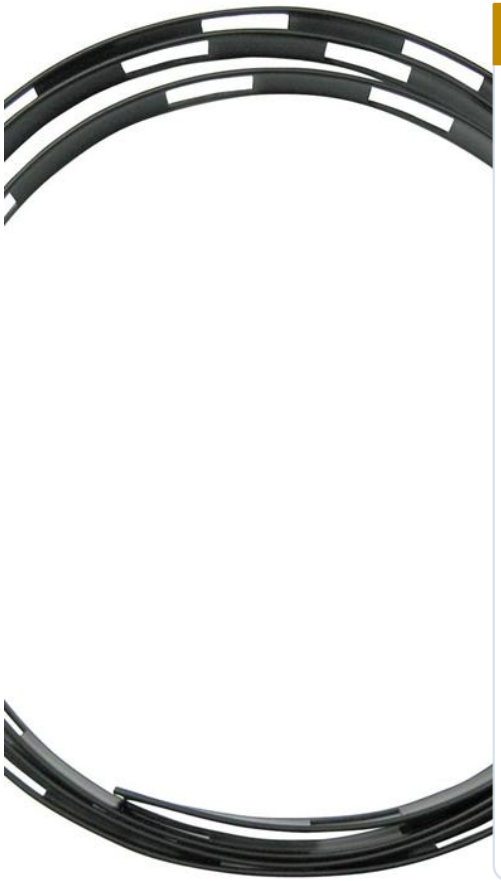
Best fit

Choose 300 Ω twin lead if you want a more compact or portable antenna and you are comfortable re-deriving the dimensions and retuning the feedpoint with an analyzer.

Builder caution

If the product is classic TV-style ribbon rather than window line, expect the geometry and trim lengths to shift more.

450Ω Ladder Line Pros and Cons



Why you might choose it

Pros

- Lower loss and less dielectric loading
- Commonly used in published Slim Jim designs
- Often better outdoor durability and power handling
- Usually a more repeatable starting point for tuning

Cons

- Bulkier and stiffer than many 300 Ω products
- Not as compact for pack-up portable use
- Can need better strain relief because it is less floppy
- Still requires trimming and feedpoint adjustment

Best fit

Choose 450 Ω ladder line if you want the highest chance that a published 2 m Slim Jim recipe will land close on the first try and you want a more durable outdoor antenna body.

Builder caution

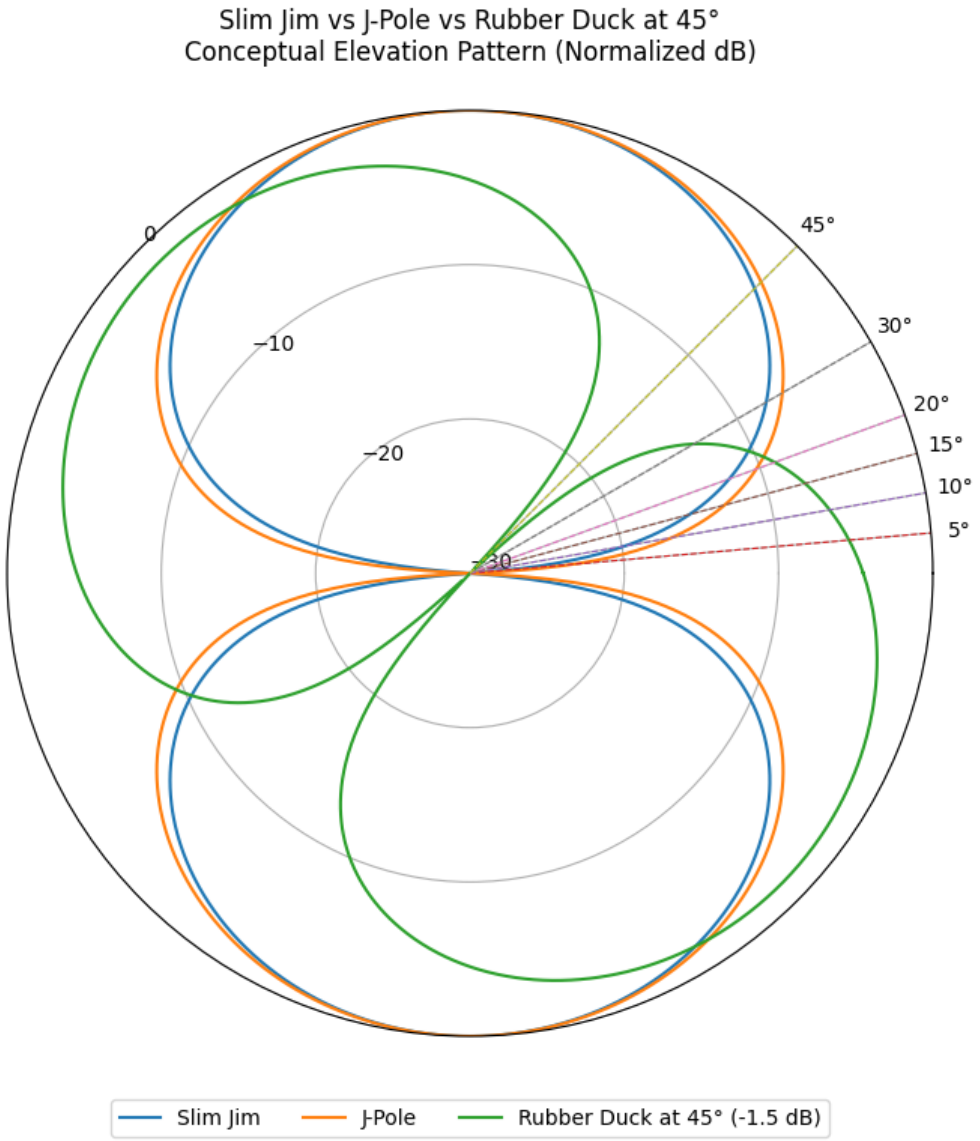
Even with 450 Ω line, final resonance and feedpoint still depend on exact line width, spacing, end effects, and nearby mounting materials.

What Usually Fails First

- Coax-to-ladder-line feedpoint
- Bottom short
- Gap area
- Poor solder joints
- Moisture ingress into the ladder line
- Lack of a choke causing high common-mode current and heating

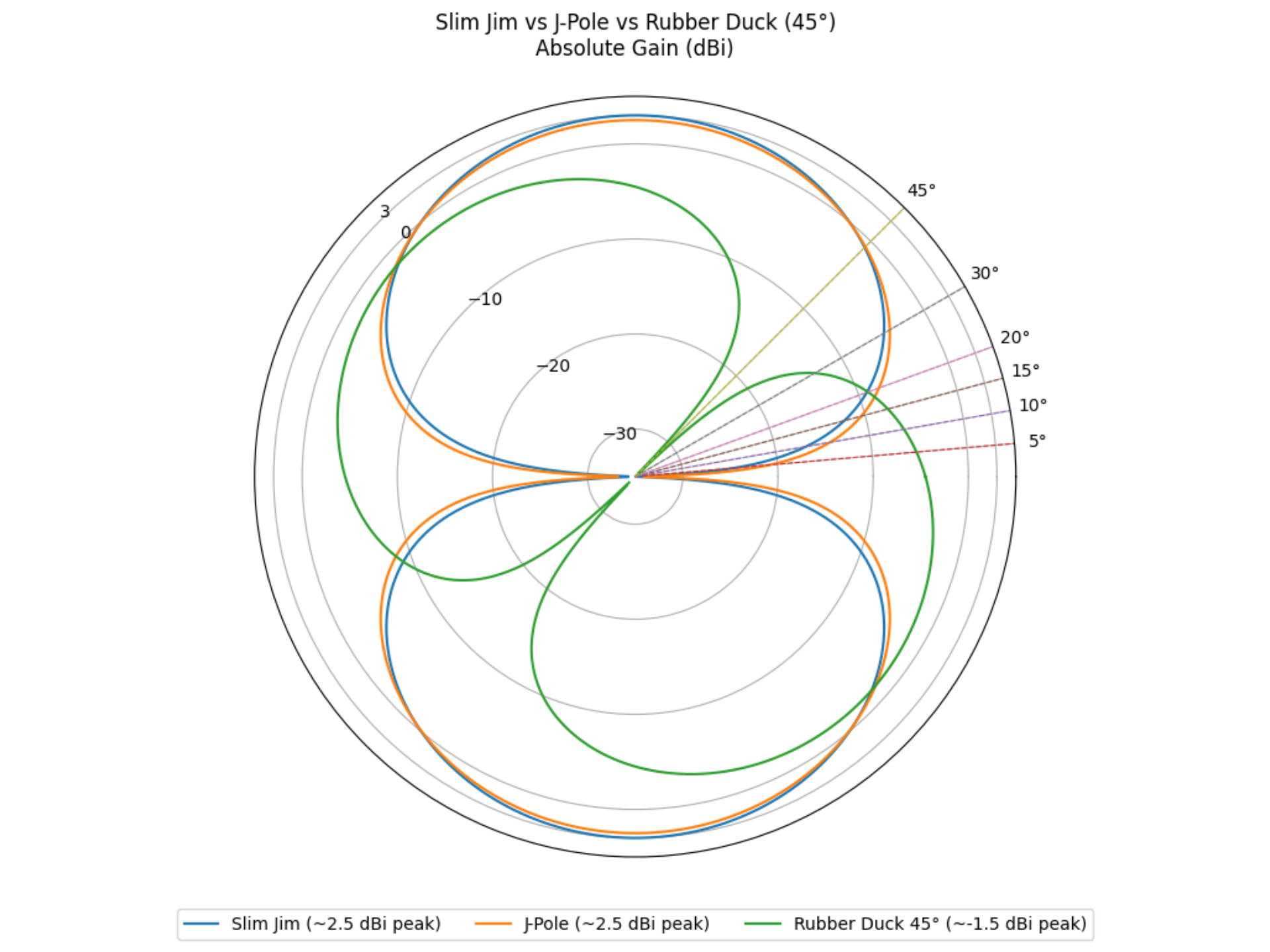
Antenna Characteristics and Performance

- Gain:
  - Slim Jim and J-pole in free space: 2.2 dBi
  - Slim Jim and J-pole over ground: 2-2.5 dBi at horizon
  - Stock rubber duck: about -1 to -8 dBi
  - “Best” rubber duck, 16” Diamond SRH77CA: 0-2 dBi
- Both are usually **much better than a handheld rubber duck**, often by roughly **3 to 6+ dB**, sometimes more, depending on the duck
- Why the numbers vary so much:
  - Feedline routing and choking
  - Nearby metal or mast effects
  - Antenna height
  - Whether the rubber duck is on a handheld next to your body
  - Exact design and tuning
- All are vertically polarized when mounted/held vertically
- TIP: The first third of the Slim Jim (matching section) does not radiate any useful power
  - If putting the antenna in an attic, or fitting it into a window frame, you can bend outwards the part below the top of the gap by up to 90^{o}



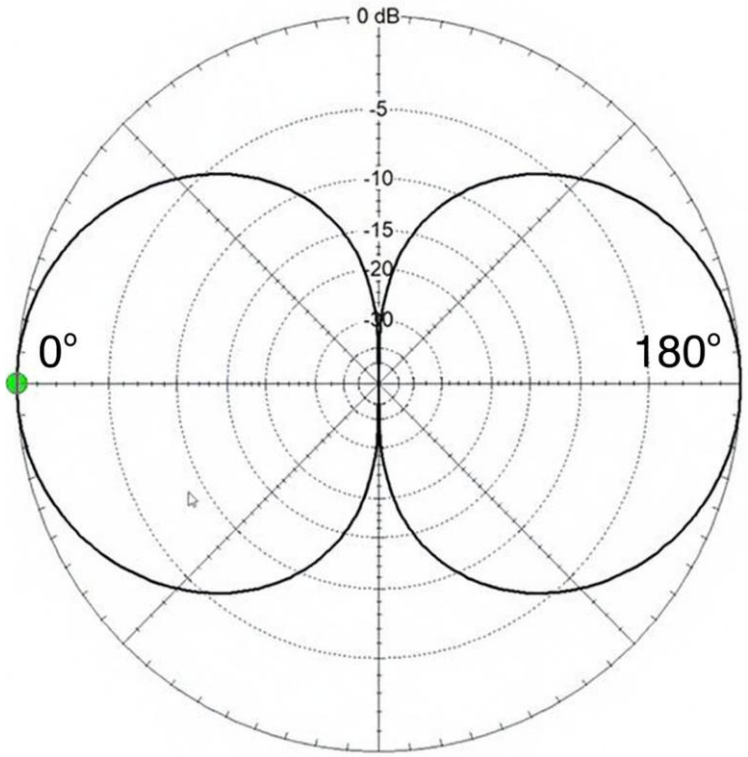
"Normalized dB" in **free space**: Each antenna pattern is scaled so that its own maximum value = 0 dB

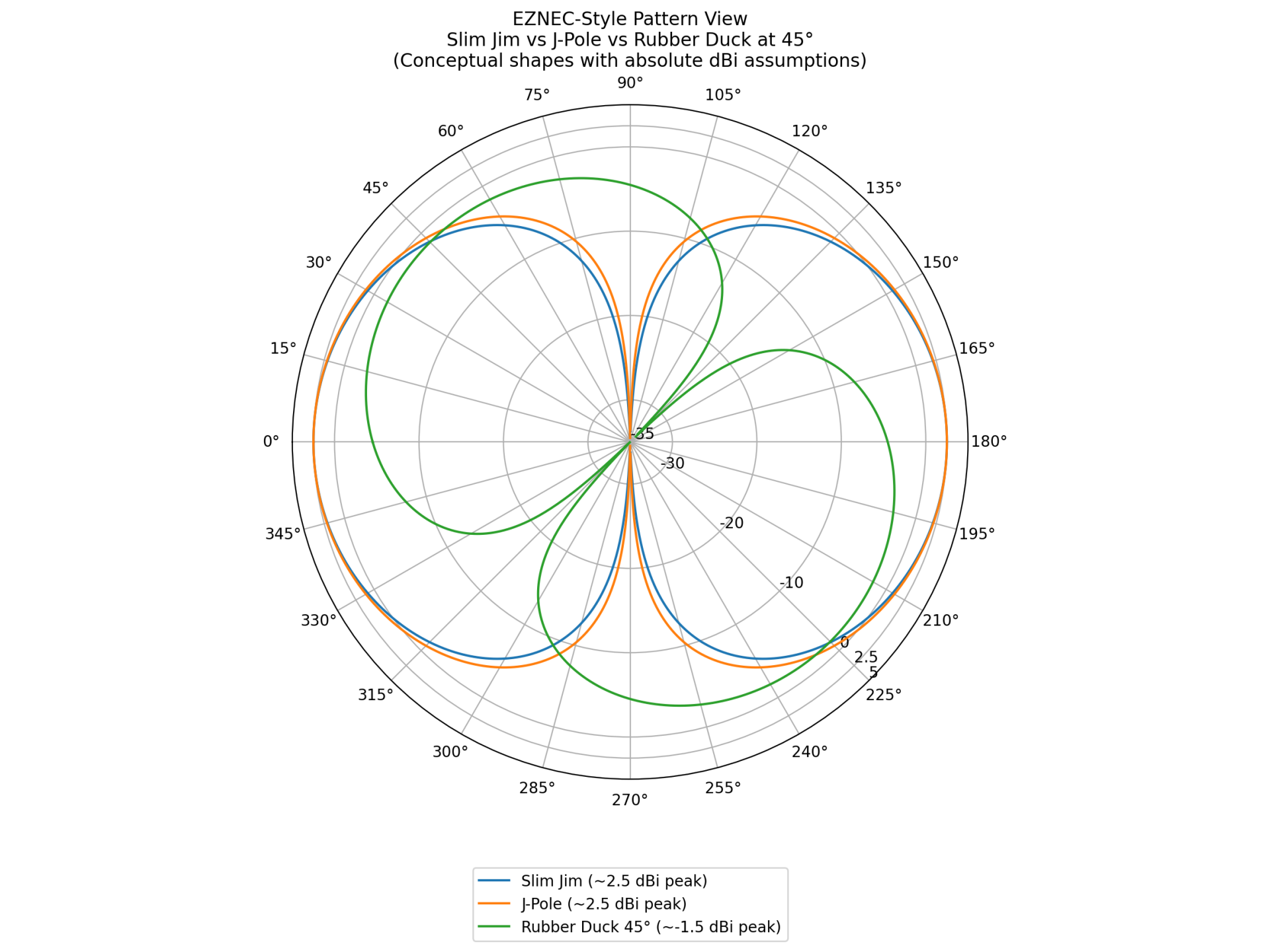
- The **strongest radiation direction** for each antenna is set to **0 dB**
- All other angles are shown relative to that peak
- The radial scale (0, −10, −20, −30 dB) shows **how much weaker other angles are compared to that antenna's own maximum**
- It does **not** show absolute gain in dBi.


Slim Jim vs J-Pole vs Rubber Duck (45°)
Absolute Gain (dBi)
3
0
−10
−20
−30
45°
30°
20°
15°
10°
5°
Slim Jim (~2.5 dBi peak)
J-Pole (~2.5 dBi peak)
Rubber Duck 45° (~-1.5 dBi peak)

EZNEC Pro/2+ Total Field Plot

- This is a standard EZNEC way of showing the elevation plot for a Slim Jim
  - Unlike the conceptual plots, uses physics to show the pattern over ground, not in free space
    - The low takeoff angle is typical over real/average ground
  - 2D slice through a 3D radiation pattern
  - Current distribution produces maximum radiation perpendicular to the antenna axis
  - Deep nulls are along the axis at 90º and down at 270º
  - Maximum gain is to the horizon
  - -3 dB beanwidth is 77º, centered on the horizon
- Conceptual plots show the “big picture” quickly
  - Maximum radiation is towards the horizon
  - Null overhead
  - Strip away real-world complexities to highlight the fundamental donut/figure-8 pattern
  - Use linear or normalized scales (e.g., 0-10 relative power)
  - Lack exact:
    - dBi gain
    - Takeoff angles in degrees
    - Beamwidth




EZNEC-Style Pattern View
Slim Jim vs J-Pole vs Rubber Duck at 45°
(Conceptual shapes with absolute dBi assumptions)
90°
75°
105°
60°
120°
45°
135°
30°
150°
15°
165°
0°
180°
345°
195°
330°
210°
315°
225°
300°
240°
285°
255°
270°
-35
-30
-20
-10
0
2.5
5
Slim Jim (~2.5 dBi peak)
J-Pole (~2.5 dBi peak)
Rubber Duck 45° (~-1.5 dBi peak)

Common Myths About The Slim Jim

Especially in Amateur Radio Circles

- The Slim Jim has significantly more gain (e.g., 2–3 dB, 6 dBi, or even 7–10 dBi/dBd) than a standard J-Pole or a simple half-wave vertical
  - Both are essentially end-fed half-wave antennas (the Slim Jim uses a folded radiator, but the current distribution is very similar).
  - Free-space gain is around 2–2.5 dBi for either (comparable to a center-fed half-wave dipole)
  - Over real ground, you get a bit more low-angle reinforcement, but no meaningful extra gain from the folding
- The Slim Jim has a dramatically lower takeoff angle (e.g., 8° vs. 20° for a J-Pole) and a more compressed/low-angle lobe for better distant performance
  - When properly built, decoupled (good choke to kill common-mode currents), and compared fairly (same height/mounting), the elevation patterns are nearly identical
- The Slim Jim is always superior to a J-Pole in every way (gain, pattern, bandwidth)
  - They're functionally equivalent electrically

Common Myths About The Slim Jim

Especially in Amateur Radio Circles (cont)

- The Slim Jim is immune to common-mode currents or doesn't need a choke/balun
  - Like the J-Pole, it's end-fed with a quarter-wave stub, so common-mode currents easily flow on the coax shield or any conductive support (mast/tree branch)
    - Distorts the pattern
    - Raises takeoff angle
    - Causes RFI
- It's a "magic" high-performance antenna that outperforms commercial verticals like 5/8-wave or collinear designs
  - Beats rubber ducks and quarter-waves
  - Doesn't beat true gain antennas (e.g., 5/8-wave over good ground plane or stacked collinear) in raw gain or low-angle performance
- You can run high power (hundreds of watts) through a ladder-line Slim Jim without issues
  - Ladder-line versions (300/450 ohm) are low-power/portable designs
  - Safe limits are typically 20–50 W for 300 ohm and up to ~100 W for 450 ohm, at low SWR
  - Higher power risks heating, arcing at the stub gap, or melting the dielectric, especially on continuous modes like FM

Construction Video Demonstration by K8MRD

https://www.youtube.com/watch?v=igHQ3EsE5Bk

Trim Sensitivity at 146 MHz

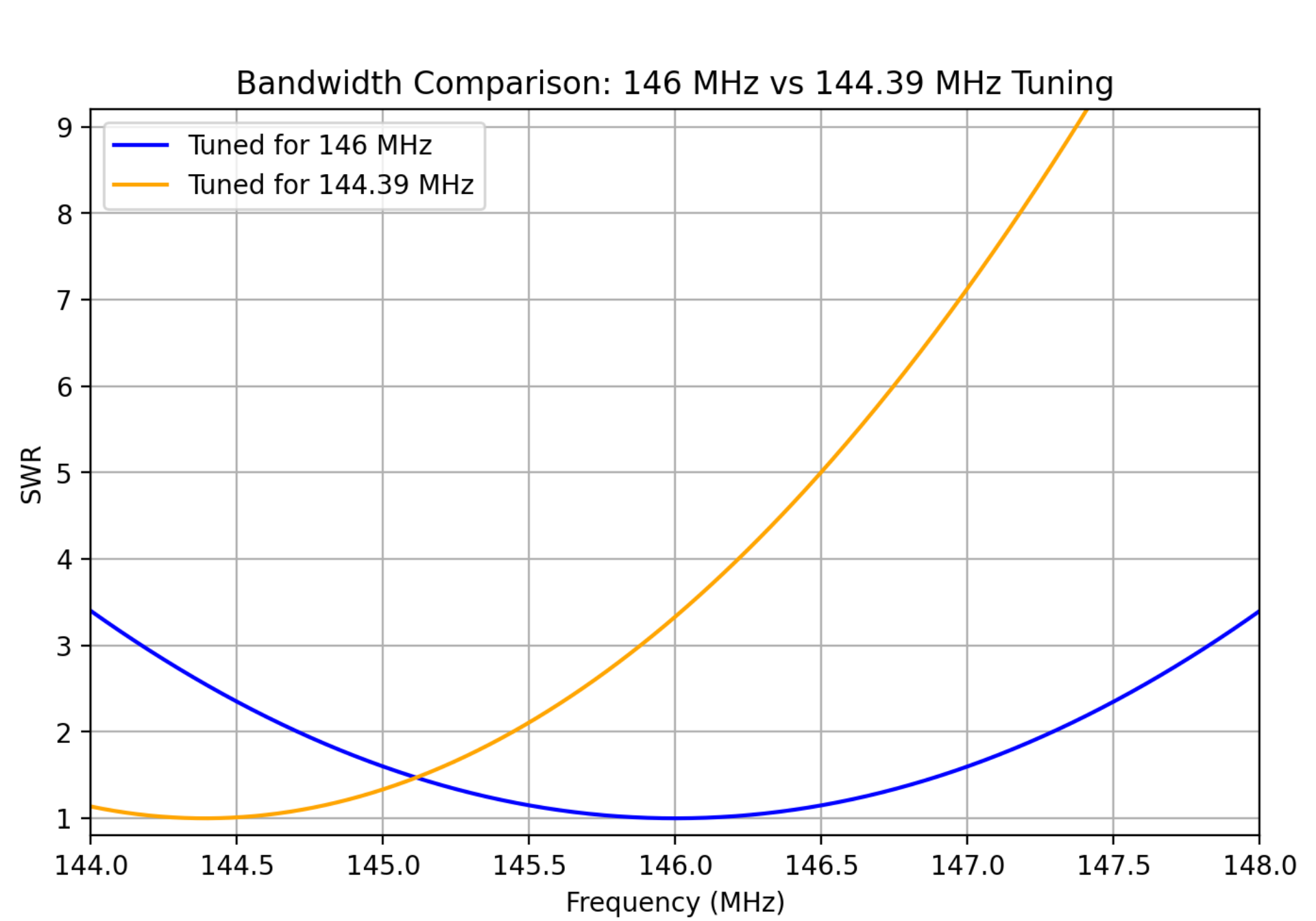
- On 2m, 1/8 inch trim ≈ 150–250 kHz shift
  - Always cut slightly long
  - Trim in 1/16–1/8 inch increments
  - Measure after each trim
  - Small changes matter at VHF
- Use an SWR meter or analyzer to slide the coax feedpoint up/down the stub for the best match
  - That's the real key to success

Feedline Current and Choke Balun

- Why Use a Choke Balun:
  - Slim Jim is asymmetrically fed
  - Without choke, feedline becomes part of antenna
  - Common-mode current distorts pattern
    - Typically increasing the takeoff angle
  - At higher TX power levels, common-mode current can cause significant heating and antenna failure
  - Add 5–6 turns RG-8X or RG213
    - 4–6" diameter loops
    - RG213 has significantly lower loss
      - Best at VHF frequencies
    - Alternatively, add snap-on ferrites
  - Place choke directly at feedpoint

APRS Version – 144.390 MHz 450Ω Ladder Line (VF 0.96)

- Overall length: 58.90 in
  - Radiator: 39.26 in
  - Stub: 19.63 in
  - Feedpoint: 1.96 in above short
  - Cut slightly long and tune to 144.39 MHz
- Optimization:
  - Center exactly at 144.39 MHz
    - Slightly narrower bandwidth acceptable
    - Tune for lowest SWR at APRS frequency
    - Ideal for fixed digipeater or iGate



NOTE: Using better quality ladder line with larger gauge wire would allow full band coverage

References

- M0UKD Slim Jim and J-pole Calculator
  - https://m0ukd.com/calculators/slim-jim-and-j-pole-calculator/
- K8MRD Construction Video
  - https://www.youtube.com/watch?v=igHQ3EsE5Bk
- Rather buy one than build one?
  - https://n9taxlabs.com/


Q & A