Resonant vs Non-Resonant Antennas: Getting on the Air with What You Have

TARA February 2026
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What an Antenna Really Does

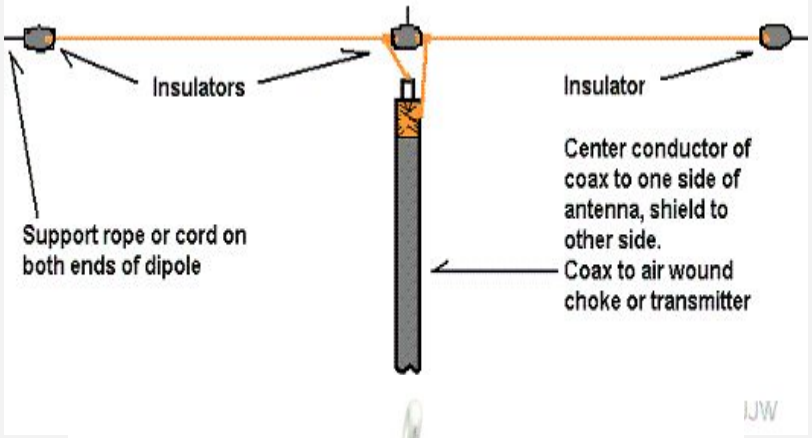
- Antenna is the link from your radio to free space
- On Transmit: Radio Frequency (RF) current in the element creates changing electric and magnetic fields that leave the antenna as a radio wave
- On Receive: Those fields push electrons in the element, creating RF voltage and current that your radio can amplify.
- Antennas are reciprocal: What works well on transmit usually works well on receive

Wavelength and Size

- For efficient radiation, antenna dimensions are a significant fraction of a wavelength
- Common examples are the half-wavelength dipole, quarter wave vertical, or ⅝ wave vertical
- Long wavelength radio frequency mean a physically larger antenna for the same fraction of a wavelength
- This is why 80m (75m or 80m actually) and 160m antennas are so physically challenging for small yards. And now 630m band which is nearly a half mile long

The Half-Wave Dipole

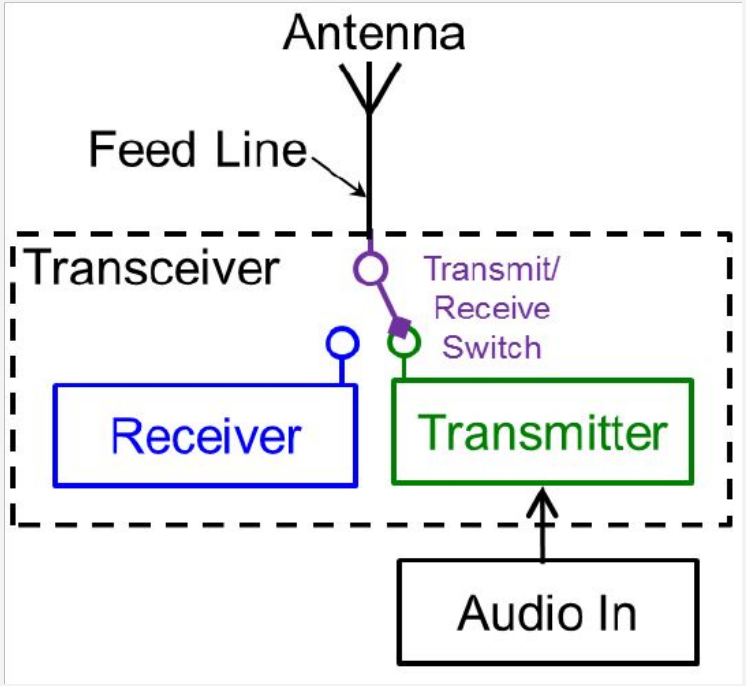
- It’s the simplest practical antenna: a straight conductor about a half wavelength long
- Fed in the center so that each leg is a quarter wavelength
- Classic pattern is broadside to the wire
- At resonance, the feedpoint impedance is mostly resistive and near the range we like for easy matching



Basic Antenna System Block

Radio -> Feedline -> Antenna

- Add a tuner or matching network anywhere in the chain to make impedances play nicely
- On HF feedlines are usually coax, ladder line, or open wire line
- An Antenna system is just Feedline and Antenna working together



What “Resonant Antenna” means

- An antenna is resonant when it’s input reactance is near zero at a given frequency
- At that frequency it looks mostly like a pure resistance load
- A resonant antenna with the right resistance is easy to match to 50 ohm gear
- A half wave dipole is usually near 50-75 ohm at resonance

Why We Love Resonant Antennas

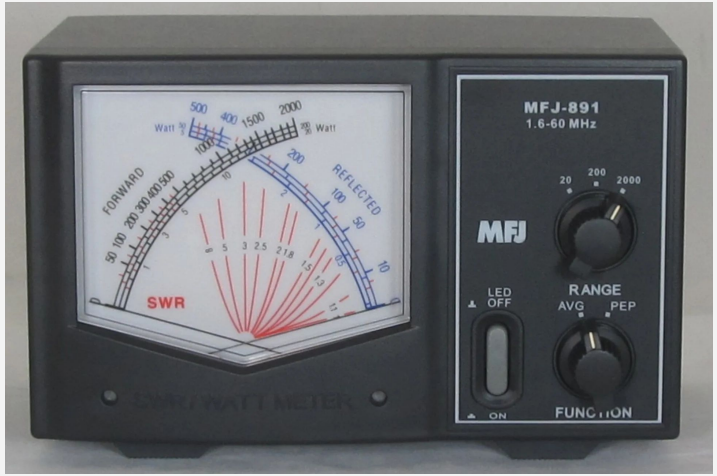
- Easy to feed with 50 ohm coax
- Low SWR at the radio without a tuner
- Predictable performance across a modest bandwidth
- Great for:
  - Single-band/monoband radios
  - Contest or POTA setups optimized for one band

The Catch: Bandwidth and Size

- The cost of these is paid for with their narrow bandwidth. SWR rises as you tune from the design frequency
- On low bands a resonant half wave can be very long and not cover the whole band
- Resonant multiband designs using traps or fans add complexity and introduce loss or interactions between fans
- Many real stations have limited space, height, and budget

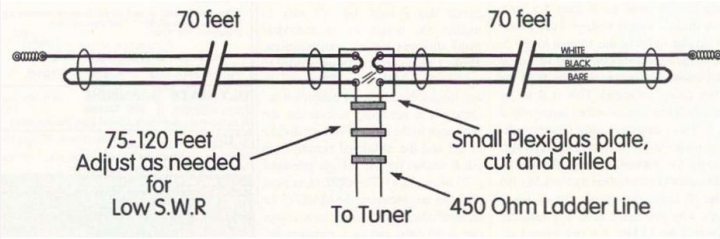
SWR: What it is (and isn't)

- Standing Wave Ratio (SWR) is a measure of mismatch between load impedance and line impedance
- A perfect 1:1 SWR means no reflected power on the line at that frequency
- High SWR means more reflected power on that line, not necessarily a "bad antenna"
- Low SWR at the rig **does not** guarantee efficient radiation if you burned power up in a lossy, mismatched feedline



Non-Resonant Antennas

- A *non-resonant* wire just means its impedance is not purely resistive at the frequency of interest
- It might still radiate very efficiently as long as current flows
- The tuner/matching network can cancel reactance and transform resistance
- With the right feedline and tuner, one non-resonant wire can cover many HF bands



The Cobra Antenna

Think in Terms of the Whole System

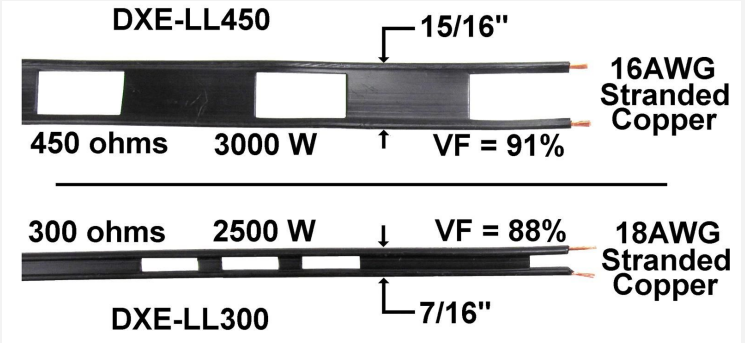
- Antenna system = Wire + Feedline + Tuner + Ground/Counterpoise + Radio
- Goal is to present a safe, acceptable load to the radio and send as much RF as possible into space
- You can choose where you pay for mismatch
  - Heat as lossy coax at high SWR
  - In matching components like a tuner or network plus low-loss line
- The second option often wins for multiband HF

Why Coax Struggles with High SWR

- Coaxial cable has higher loss per foot compared to open wire or ladder line at HF
- When SWR is high on coax, voltage and current peaks will increase loss and heating of the coax
- Long runs of small diameter coax with high SWR can waste a lot of potentially radiated RF power as heat
- That can make a good antenna look bad at the radio or even a bad antenna look good at the radio

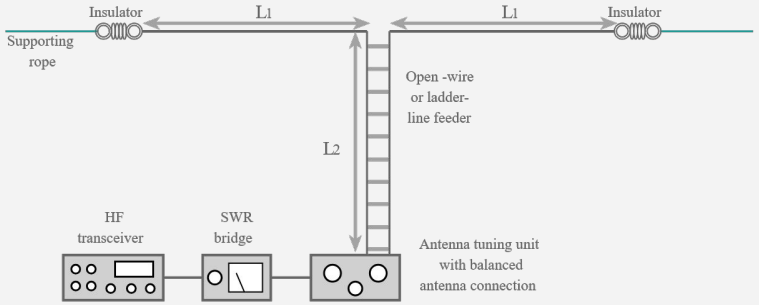
Entering the party: Ladder line / Open Wire Line

- Twin lead/Ladder line/Open wire line (300,450,600 ohm) has very low loss at HF compared to typical coax
- It tolerates high SWR with minimal additional loss
- Higher characteristic impedance means lower currents for a given power, reducing resistive loss
- Common values are 300, 450, 600 ohm



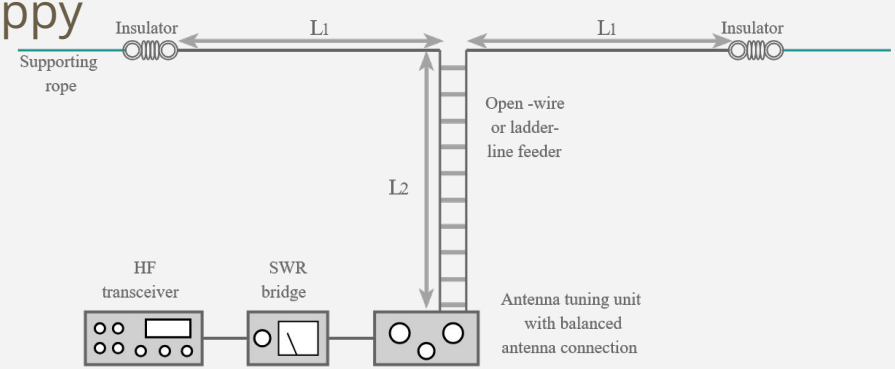
The Non-Resonant Doublet Concept

- Take a length of wire, often 80-135 feet total, fed in the center
- Use 450 or 600 ohm ladder line from the center feed point to the shack
- Use a tuner and often a balun, to match whatever impedance appears at the shack back to a 50 ohm load
- Result: One antenna that can cover multiple bands
  - Often 80m to 10m including WARC
  - This sets apart from using harmonics to cover 40/20/10



Ugly SWR on the Line but Still a Happy Radio

- Impedance along the ladder line may vary with frequency
- SWR on the line may be 5:1, 10:1, or more - and it’s fine with low-loss ladder or open wire line
- The tuner cares only about the impedance it sees at the antenna input
- As long as the tuner can transform or match that to 50 ohm then the radio will see 1:1 SWR and is happy



Why This Works So Well in Practice

- Ladder line + Tuner lets you
  - Use one wire on many bands
  - Get good efficiency even with high SWR on the line
  - Adapt to awkward lengths and layouts that are dictated by your property limits
- Performance can rival or beat a resonant, single band dipole on many bands especially if the coax runs are long
- Copper wire was invented by two hams fighting over a penny
  - Use it to our advantage because many power levels we run can be done with 18/20/22 gauge wire

How an Antenna Tuner *Really Works*

- Your transmitter wants to see and 50 ohm, non-reactive load at the output
- A mismatched antenna/feedline presents some other complex impedance (R ± jX)
- The tuner is a reactive matching network (L/C) that **transforms** the impedance to 50 ohms at the radio port
- In an ideal tuner, the reactive parts store and release energy but do not dissipate it as heat
- Reflected power from the mismatch is “re-reflected” back towards the antenna and added in-phase to the new forward power
- Result is the radio sees a good match, runs full power, and most of that power is forced out into the antenna system, not burned up in the tuner

Tuner and Balun Considerations

- Ideal is a true balanced tuner that directly feeds your ladder line
- Common practice however, is a current balun that transforms ladder line to coax
- Place the balun on the balanced side of the tuners output if possible
  - Reference your manual, many tuners have 4:1 current baluns already on there but some don’t
- For many doublets a 1:1 current balun is a good starting point but a 4:1 current can help depending on the impedances
  - Use an antenna analyzer and perform a full sweep on the bands intended to be used
- https://www.balundesigns.com/doublets/

Practical Station Recipe

1. Antenna: 88 to 135 feet total, center-fed (not offset), as high as you can
2. Feedline: 450 ohm ladder line from the center to the shack bulkhead
3. At the shack
   a. Ladder line to a 1:1 current balun
      https://www.balundesigns.com/model-1151-1-1-atu-current-balun-1-54-mhz-2kw/
   b. Balun to a manual tuner or auto tuner
   c. Tuner to 1:1 choke balun
      https://www.balundesigns.com/copy-of-model-1110-qrp-1-1-isolation-choke-balun-1-5-54-mhz-300-watts/
4. Bands: Commonly used 80/60/40/30/20/17/15/12/10/6

Choices in a Real Yard

- Single-band resonant dipole + 1:1 current balun + coax
  - Pros: simple, efficient, no tuner needed on that band
  - Cons: mostly only one band, space/height demands on lower bands is excessive
- Trap or fan dipole + 1:1 current balun + coax
  - Pros: multiband with one feedline, often no tuner for bands built for
  - Cons: more complex, traps add loss, interactions between elements, still big
- Non-Resonant doublet + open wire line + 1:1 current balun + tuner
  - Pros: wide band coverage, extremely low feedline loss, flexible layout
  - Cons: needs a tuner and usually a balun, can be trickier to route line and manage RFI

Practical Tips and Gotchas!

- Keep ladder line away from metal gutters, siding, and long parallel runs of other wiring when possible
- Avoid running ladder line flat on the ground or tightly against walls
- Expect trial and error for; Wire length, ladder line length, tuner settings
- Check for RF in the shack. Hot mic or chassis, RF burns, devices acting up and address with chokes on the power cord or re-adjust the shack setup

Safety and Power Handling

- High SWR along the line can create high voltage and current points
- Use components (baluns, tuners, insulators) rated for your power plus a safety margin
- Keep high RF areas out of reach of people and pets and pests
- Be cautious near trees, metal roofs, and power lines; follow all safety rules and codes

Key Takeaways

- Antennas are just devices that couple RF energy between your radio and space. Resonance is one useful condition, not a requirement
- A low SWR at the rig is about matching, not automatically about radiation efficiency
- Non-Resonant doublets fed with 450 or 600 ohm line plus a tuner are powerful, flexible tools for real-world stations (yours!)
- Use the whole **antenna system** to your advantage: wire length, feedline type, and matching network all work together

Questions/Discussion/Show and Tell

Who runs a non-resonant antenna with a tuner?

Anyone using 450 or 600 ohm wire?

Compromised antenna layout is perfect for POTA

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Account Status

DXCC Award	New LoTW QSLs	LoTW QSLs in Process	DXCC Credits Awarded	Total (All)	Total (Current)
Mixed	56	0	100	156	156
CW	2	0	0	2	2
Phone	60	0	8	68	68
Digital	58	0	92	150	150
Satellite	1	0	0	1	1
160M	3	0	0	3	3
80M	43	0	3	46	46
40M	73	0	10	83	83
30M	88	0	23	111	111
20M	61	0	28	89	89
17M	87	0	24	111	111
15M	92	0	12	104	104
12M	82	0	0	82	82
10M	79	0	0	79	79
6M	3	0	0	3	3
Challenge	609	0	100	---	709