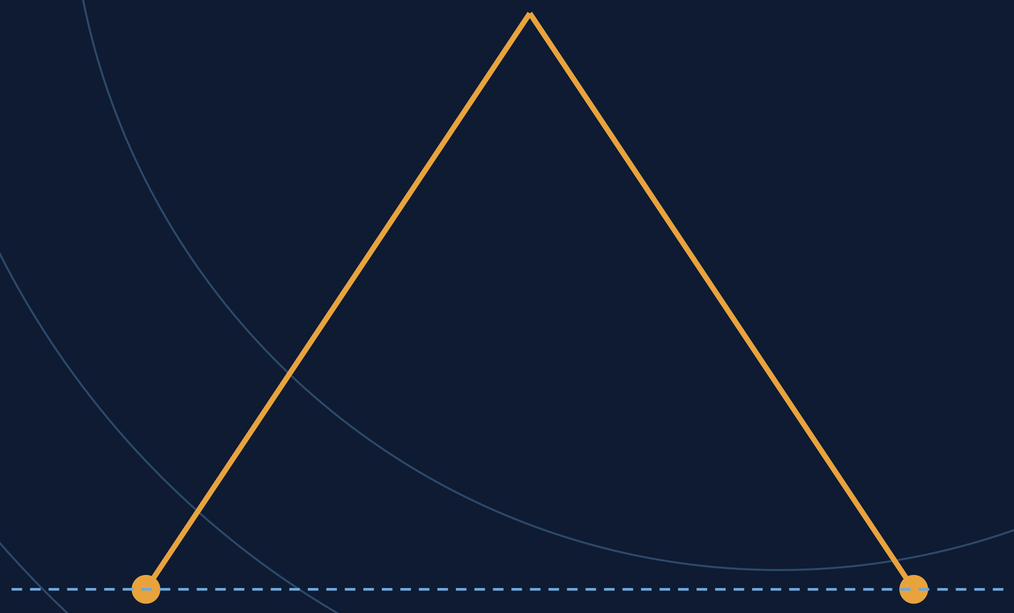
HF ANTENNAS

for the Amateur Station

Wire, vertical and beam systems — how each one radiates, what it covers, and what it costs you.

Dipoles · OCF · Fan & Linked · EFHW · Random Wire · Delta Loop · Verticals · Yagi · Hexbeam · Portable Kits · Chokes & Baluns



Height, Angle, Distance

Before we compare antennas: three variables decide almost everything an HF antenna does.

1 EFFICIENCY

How much power leaves as RF instead of heating ground, traps, coils and lossy transformers.

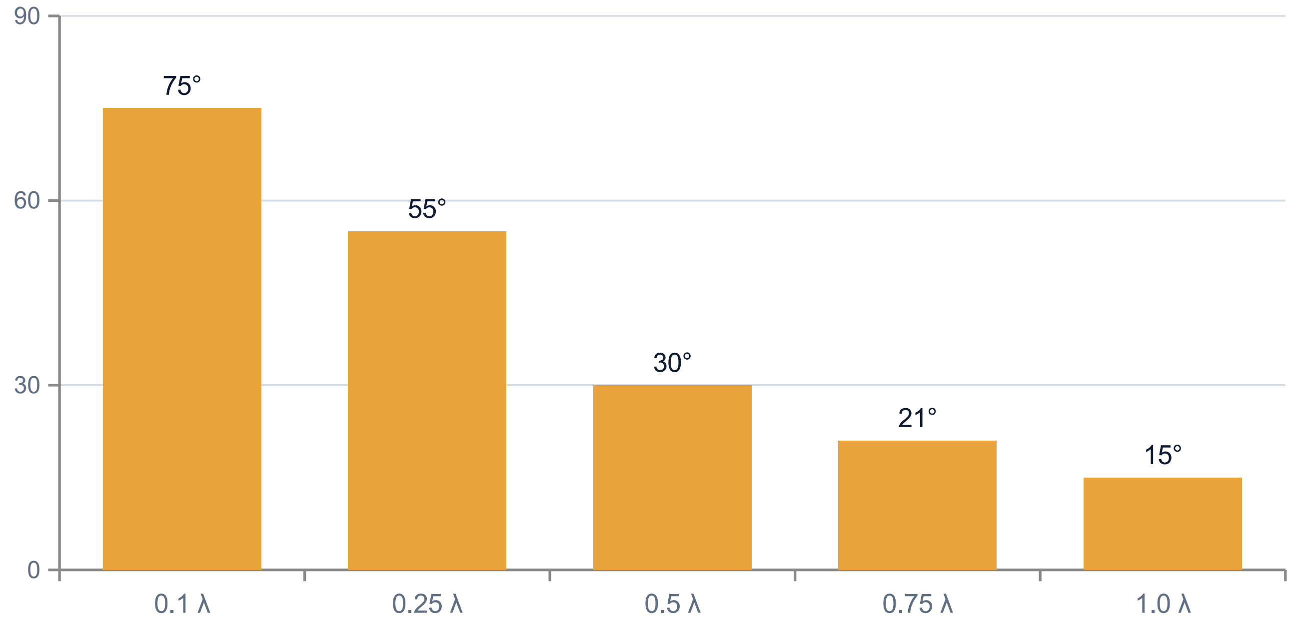
2 TAKEOFF ANGLE

The elevation angle of the main lobe. This — not gain — decides whether you work 200 miles or 8,000.

3 BANDWIDTH & MATCH

How much of the band you can use before the tuner (and its losses) has to get involved.

Horizontal antenna height vs. peak takeoff angle



WHAT THE ANGLE BUYS YOU

75–90° **0–300 mi**

NVIS — straight up and back down. Nets, county traffic, no skip zone.

45–60° **300–800 mi**

Regional ragchewing. A low dipole's natural home.

25–40° **800–2,000 mi**

One long hop. Coast to coast on 20 m.

10–20° **2,000 mi +**

The DX window. Verticals, beams and high wires live here.

Rule of thumb: a horizontal antenna needs to be at least a half wavelength up before it is a serious DX antenna.

The Half-Wave Dipole

The reference antenna. Every other design in this deck is measured against it.

BAND COVERAGE

Resonant where it is cut, plus ODD harmonics only. Even harmonics put the feed point at a voltage maximum — thousands of ohms — which is why a 40 m dipole will not load on 20 m. Ladder line into a balanced tuner gets 80 through 10 m from one wire. Length ≈ 468 / f (MHz) feet, then trim.

PROPAGATION IN PRACTICE

Height is everything. A 40 m dipole at 30 ft is only 0.22 λ up: it fires almost straight up, giving reliable NVIS coverage to about 300 miles and little beyond. Raise it to 65 ft (0.5 λ) and the main lobe drops to about 30°, opening 1,000–2,500 mile paths. Broadside off the sides, nulls off the ends, so orientation is free steering. On 15 m that same wire is 3 λ/2 long and the pattern changes entirely: four major lobes about 42° off the wire axis, with the broadside pair roughly 3 dB down.

Half wave, center fed, current maximum in the middle

STRENGTHS

- Cheap, predictable, and easy to model — you know what you are getting
- No ground system or radial field required
- Broadside pattern you can aim simply by orienting the wire
- Handles full legal limit with nothing but wire and an insulator

TRADE-OFFS

- Needs two supports and about 66 ft of clear span on 40 m
- Single band unless you feed it with open wire and a tuner
- Performance collapses when hung low — low band DX suffers badly
- Pattern skews if the legs bend, droop or run near metal

AT A GLANCE

Feed point Z	50–70 Ω at a half wave up
Matching	1:1 current balun / choke
Length	468 / f (MHz) feet
Harmonics	40 m → 15 m (3rd). Never 20 m.
Gain	0 dBd — the reference

15 m is the only harmonic that lands on a useful band: the 5th falls between bands at 35.7 MHz, and the 7th reaches 6 m but with a 14-lobe pattern.

The Off-Center-Fed Dipole (Windom)

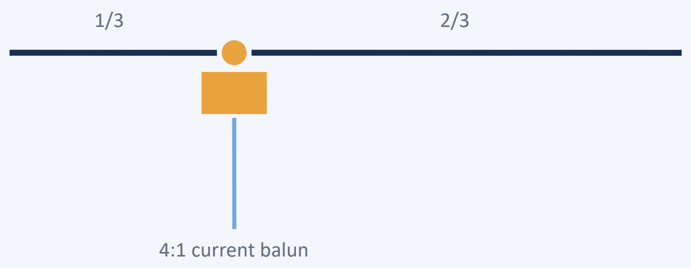
One wire, one coax, many bands — with one caveat you cannot ignore.

BAND COVERAGE

Fed roughly one third from an end through a 4:1 (sometimes 6:1) current balun. A 135 ft OCF typically loads 80, 40, 20, 17, 12 and 10 m without a tuner, and most tuners will fill in 30, 15 and 6 m. A 66 ft version does 40 through 6 m.

PROPAGATION IN PRACTICE

At a typical 40 ft it behaves as a cloud-burner on 80 and 40 m and progressively lower-angle as the frequency climbs. Above 20 m the pattern breaks into multiple lobes with deep nulls between them — you will hear strong DX in some directions and nothing at all in others, and rotating your house is not an option. An excellent all-rounder, not a precision instrument.



Feed point at the one-third point, 4:1 balun to coax

STRENGTHS

- Six-plus bands from one wire and one coax run — no tuner on design bands
- Only two supports needed; works well as an inverted-V or sloper
- Very popular commercially, so ready-made versions are easy to buy
- A genuine set-and-forget antenna for a general-purpose station

TRADE-OFFS

- The feedline becomes part of the antenna unless choked hard
- RF in the shack is the classic OCF complaint — budget for chokes
- Lobe structure is complex and unpredictable on the higher bands
- 4:1 balun adds loss and can get hot at high power on some bands

AT A GLANCE

Feed point Z	≈ 200–300 Ω
Matching	4:1 or 6:1 current balun
Length	135 ft (80 m) / 66 ft (40 m)
Must add	1:1 choke below the balun

Buy or build the version with a current balun, not a voltage balun — the difference shows up directly as common-mode current on your coax.

Fan and Linked Dipoles

Parallel resonant wires for the home station; jumper links for the trail.

BAND COVERAGE

Fan: two to four dipoles sharing one feed point and one coax. A common 80 / 40 / 20 m build also gives you 15 m free on the 40 m leg's third harmonic — but not 10 m, which needs a leg of its own. Linked: one pair of wires broken by insulated links, so 40 / 30 / 20 / 17 / 15 m is the standard portable set. Both are fully resonant, so no tuner sits in the signal path.

PROPAGATION IN PRACTICE

Each band radiates exactly like a plain dipole at that height. That is the quiet advantage of a fan: because a fixed 40 ft support is 0.29 λ on 40 m but 1.2 λ on 10 m, the same antenna is an NVIS radiator on the low bands and a genuine 20–25° DX antenna on the high ones, with no compromise anywhere in between.

Fan: parallel legs on one feed point, shortest on top

FAN DIPOLE — FIXED STATION

- One feedline, no tuner, instant band changes
- Full legal limit, zero matching loss
- Wants a 1:1 current balun at the feed point, same as any dipole
- Legs interact — expect a fiddly trim-and-retest cycle

LINKED DIPOLE — PORTABLE

- Lightest truly resonant multi-band antenna there is
- Nothing lossy in line — best efficiency per gram in the pack
- Still wants a choke; a clip-on ferrite is enough in the field
- You must lower it to change a link, so label them clearly

BUILD NOTE

Avoid harmonically related pairs — a 40 m leg and a 15 m leg fight each other, because the 40 m wire is already live on 15 m.

Spacing: join every leg at the feed point, then fan the ends apart. Keep 6–12 in between adjacent wires along the run and spread the ends 2–3 ft, using a spreader bar or separate tie-offs. Expect the shorter legs to finish a few percent shorter than the standalone formula.

Trim from the longest band down and re-check every band after each cut: they all move.

Both are balanced antennas fed with unbalanced coax, so both want a 1:1 current balun at the feed point — a fan arguably more than a plain dipole, since several legs share it.

The End-Fed Half Wave

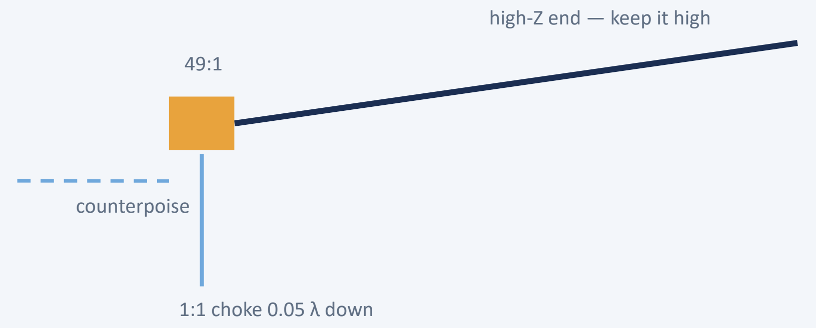
One wire, one support, five bands — the reason POTA activations look so easy.

BAND COVERAGE

A half wave on the lowest band is a whole number of half waves on its harmonics, so a 130 ft wire covers 80 / 40 / 20 / 15 / 10 m and a 65 ft wire covers 40 / 20 / 15 / 10 m. A small capacitor across the 49:1 transformer primary pulls 10 m into range. No tuner needed on the design bands.

PROPAGATION IN PRACTICE

Deployed the usual way — as a sloper or inverted-L off a single tree or mast — it has both horizontal and vertical current components. That gives you NVIS fill on 80 and 40 m and useful low-angle radiation on the higher bands from the same wire. Strung flat and high it simply behaves like a dipole with the feed point moved to the end.



49:1 unun at the near end, high-voltage end far away

STRENGTHS

- One support and one anchor — no center hoist, no second tree
- Feed point sits at the operating position, so the coax run is short
- Multi-band and resonant with no tuner and no radials to lay out
- A complete 40–10 m kit weighs under three ounces

TRADE-OFFS

- The 49:1 transformer has real loss — 0.3 to 1 dB, worse when hot
- Needs a counterpoise (≈ 0.05 λ) and a choke down the coax
- The far end sits at very high RF voltage — keep it out of reach
- SWR wanders noticeably with height, ground and nearby objects

AT A GLANCE

Feed point Z	≈ 2,400–3,000 Ω
Matching	49:1 unun (FT240-43)
Length	130 ft (80 m) / 65 ft (40 m)
Must add	Counterpoise + 1:1 choke

The transformer is an unun, not a balun — it does not choke anything. Fit a separate 1:1 choke about 0.05 λ down the coax and your noise floor will thank you.

The End-Fed Random Wire

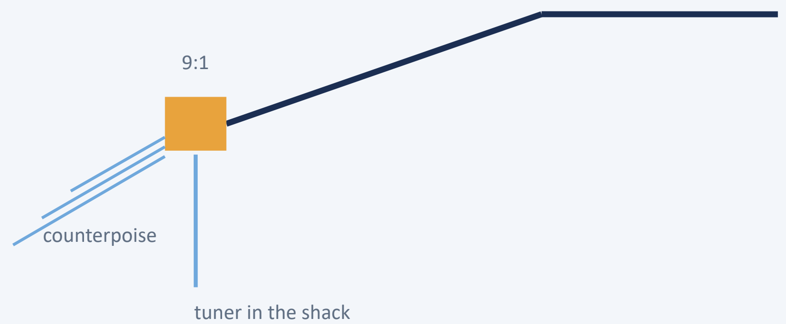
When you cannot cut for a band, let the wire be whatever fits and let the tuner sort it out.

BAND COVERAGE

In practice 160 through 6 m, limited only by your tuner's matching range. Fed through a 9:1 unun into a wide-range tuner. Choose deliberately non-resonant lengths: 29, 35.5, 41, 58, 71 and 84 ft are the classic short picks, while 124, 148 and 203 ft do far better on 160, 80 and 40 m if you have the room. Avoid anything near a half wave on a band you use — the impedance there is far too high to match.

PROPAGATION IN PRACTICE

Whatever the shape of the wire gives you. A sloping run or an inverted-L has both vertical and horizontal components and puts something in every direction, which is exactly what you want for casual operating, emergency work or a hotel window. It will not beat a resonant antenna on any single band, but it will get you on all of them.



9:1 unun, inverted-L wire, counterpoise, tuner in the shack

STRENGTHS

- Any length you can physically string up will work on something
- Stealthy — thin wire disappears against trees and rooflines
- One support; deploys in minutes in an unfamiliar location
- Field-ready kits from Chameleon and PackTenna weigh almost nothing

TRADE-OFFS

- A tuner is mandatory, and you pay its losses on every band
- Needs a genuine counterpoise or radial set — not an afterthought
- Common-mode current on the coax is guaranteed without a choke
- Efficiency varies wildly band to band; some bands are simply poor

AT A GLANCE

Matching	9:1 unun + wide-range tuner
Short lengths	29, 35.5, 41, 58, 71, 84 ft
Long lengths	124, 148, 203 ft
Counterpoise	≥ 17 ft, or ¼ λ radials
Gain	roughly −2 to −1 dBd, varies

A random wire and an EFHW look identical in the pack. The difference is the transformer ratio and whether a tuner has to be in the line.

The Delta Loop

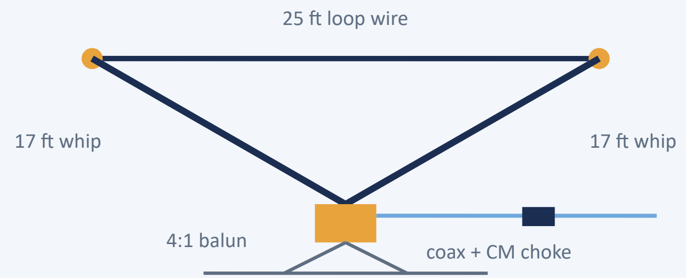
A full wavelength of wire — more gain than a dipole, quieter on receive, and increasingly the portable operator's choice.

BAND COVERAGE

Full size: 1005 / f (MHz) feet of perimeter, cut for one band and usable on its second and third harmonic with a tuner. Shortened portable kits trade size for range — the REZ Scout PDL covers 40–6 m at 500 W PEP, the Chameleon TDL 80–6 m with an ATU.

PROPAGATION IN PRACTICE

The feed point chooses your propagation. A full-size loop fed a quarter wave up from a bottom corner is vertically polarized and low-angle — real DX with no radial field. Fed at the apex or bottom center it is horizontally polarized and higher-angle, favoring regional work. The apex-down portable kits are fed at the bottom, which puts the current maximum in the top wire: broadly horizontal, quiet on receive, some broadside directivity, and usable NVIS on 80 and 40 m.



Apex-down portable loop — the REZ Scout PDL and Chameleon CHA TDL layout

STRENGTHS

- About 1–2 dB over a dipole, and a much lower noise floor than a vertical
- Closed loop — no high-voltage ends and no radial field to lay out
- Full size needs one tall support; the whip kits need no support at all
- Apex-down kits go up in five minutes on a tripod or a ground spike

TRADE-OFFS

- Feed point runs 100–200 Ω — it wants a 4:1 balun, not bare coax
- A 40 m full-size loop is roughly 46 ft on a side — a big footprint
- Shortened whip loops are compromised on 80 and 40 m and want a tuner
- Two 17 ft whips catch wind — guy or weight the tripod on open ground

AT A GLANCE

Full size	Perimeter 1005 / f (MHz) feet
Feed point Z	≈ 100–200 Ω by feed point
Matching	4:1 balun — e.g. LDG RBA-4:1
Power limit	RBA-4:1 = 100 W CW / 200 W PEP
Portable kit	2 × 17 ft whips + 25 ft wire

The LDG RBA-4:1 is a voltage balun rated 100 W continuous / 200 W PEP — add a 1:1 choke below it, and check that rating against your kit's power.

The Horizontal Loop (Skyloop)

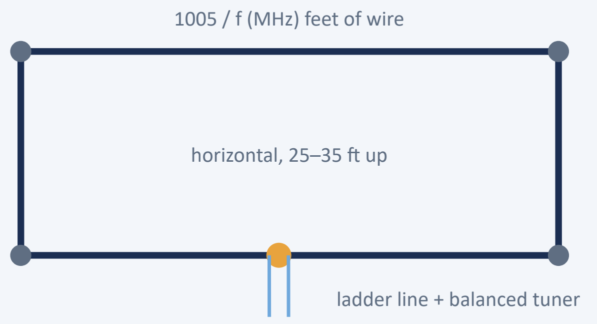
A full wavelength of wire around the yard — the quietest all-band wire antenna most people can actually build.

BAND COVERAGE

A full wavelength of wire: 1005 / f (MHz) feet. A 40 m loop is about 140 ft — roughly 35 ft square; an 80 m loop is about 279 ft. Fed with ladder line into a balanced tuner, one loop covers its fundamental and every band above it. Coax and a 4:1 balun works on the design band and harmonics only.

PROPAGATION IN PRACTICE

At a realistic 25–35 ft a 40 or 80 m loop is only a fraction of a wavelength up, so on its fundamental it fires almost straight up: superb NVIS for regional nets and traffic handling, poor for DX. Go up in frequency and that same height becomes more wavelengths — the pattern breaks into lower-angle lobes, and by 20 m and above it is a genuinely good DX antenna. One wire, two personalities, split by frequency.



Plan view: a full wavelength around the yard, corners on any supports

STRENGTHS

- Quieter on receive than any vertical — horizontal polarization rejects most local noise
- About 1–2 dB over a dipole, with a broad and forgiving SWR curve
- Every band from the fundamental up, on one wire and one feedline
- Closed loop: no high-voltage ends, no radial field, and the shape barely matters

TRADE-OFFS

- Four supports and a lot of yard — 279 ft of wire to close an 80 m loop
- On its fundamental at backyard height it is an NVIS antenna, not a DX one
- Ladder line has to run clear of metal, gutters, downspouts and the house
- ≈ 100–150 Ω feed point; coax and a 4:1 balun costs you the all-band use

AT A GLANCE

Length	1005 / f (MHz) feet
40 m loop	≈ 140 ft, about 35 ft square
80 m loop	≈ 279 ft, about 70 ft square
Feed point Z	≈ 100–150 Ω at usable heights
Best feed	Ladder line + balanced tuner

Not a magnetic loop: that term means a small loop under about 0.1 λ around. This one is quiet because it is horizontal and balanced.

Vertical Antennas — Permanent Installations

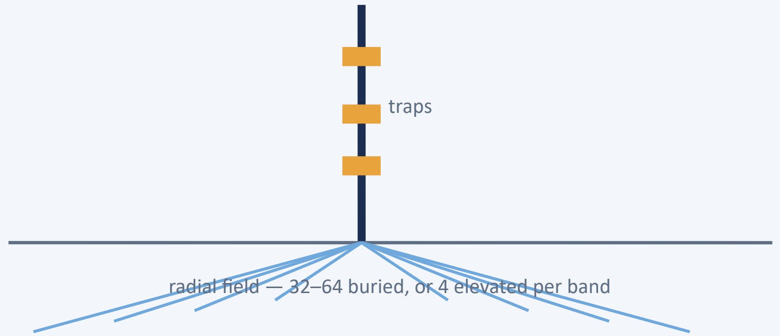
Low takeoff angle from a small footprint. It lives or dies on the radial field.

BAND COVERAGE

Trap verticals such as the Hustler 6BTV cover 80 / 40 / 30 / 20 / 15 / 10 m in 24 ft of aluminum at full legal limit. Flagpole verticals (DX Engineering, GreyLine, Zero Five) hide 30–43 ft of radiator inside an HOA-friendly fiberglass tube, usually with a remote autotuner at the base for continuous 160–6 m coverage.

PROPAGATION IN PRACTICE

A quarter wave over a good ground plane radiates at 20–25° — exactly the DX window. This is the antenna that beats a low 40 m dipole to Europe and loses to it for a 150 mile ragchew. Receive noise is higher because a vertical picks up local electrical hash efficiently, so many operators transmit on the vertical and listen on a loop or beverage on the low bands.



Trap vertical with buried radial field; traps switch bands

STRENGTHS

- Omnidirectional low-angle radiation — real DX from a small lot
- No tall supports required; a 24 ft vertical fits almost anywhere
- Flagpole versions are genuinely invisible in restricted neighborhoods
- Works all bands at once with no switching or lowering

TRADE-OFFS

- Radials are not optional — 32 to 64 buried ¼ λ wires for a ground mount
- Traps narrow the bandwidth: roughly 100 kHz usable on 80 m
- High receive noise floor compared with a horizontal wire
- Efficiency drops fast over poor soil; ground loss is invisible on the SWR meter

AT A GLANCE

Example	Hustler 6BTV — 24 ft, 1 kW
Bands	80 / 40 / 30 / 20 / 15 / 10 m
Radials	32–64 buried, or 4 elevated per band
Takeoff	≈ 20–25°

Elevated verticals need only four resonant radials per band to work well. Ground-mounted ones need dozens of any length. Budget the wire before you buy the antenna.

The Yagi

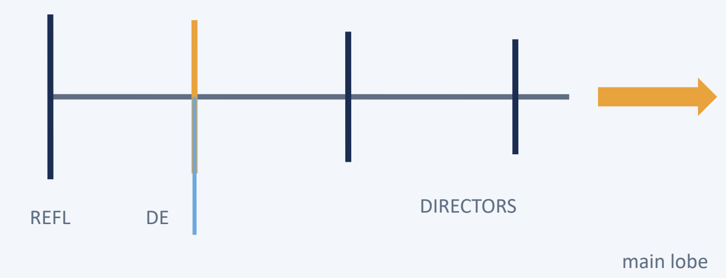
Gain, front-to-back rejection, and the ability to point all of it at one continent.

BAND COVERAGE

Monoband designs of three to six elements, or trapped and interlaced tribanders covering 20 / 15 / 10 m on one feedline. Add-on kits bring in the WARC bands at 30 / 17 / 12 m. Forty-meter Yagis exist and work superbly, but they are large, heavy and expensive.

PROPAGATION IN PRACTICE

A three-element 20 m Yagi at 70 ft is 1.5 λ up, putting its main lobe near 12–14° — squarely in the DX window — with about 20 dB of rejection off the back. That rejection is frequently worth more than the gain: it nulls out a noisy neighbor, an unwanted pileup or a European wall of signals while you work the Pacific.



Reflector, driven element, directors — pattern fires forward

STRENGTHS

- 6–9 dBd forward gain — 100 W behaves like 400–800 W
- 20 dB or more front-to-back cleans up receive dramatically
- Directivity beats brute power on both transmit and receive
- Full-size monobanders are the best-performing HF antennas available

TRADE-OFFS

- Requires a tower, mast, rotator and thrust bearing — a real project
- Wind and ice loading is a genuine structural engineering problem
- Traps in tribanders add loss and narrow the usable bandwidth
- Maintenance means climbing, and the whole system is expensive

AT A GLANCE

Gain	≈ +7.5 dBd (3-el tribander)
Front / back	18–25 dB
Boom	16–24 ft; turning radius 15–20 ft
Wind load	8–12 sq ft

Height still wins: a two-element beam at 70 ft will usually out-perform a four-element beam at 35 ft on DX paths.

The Hexbeam

Most of a tribander's punch, a quarter of its wind load — and it fits on a push-up mast.

BAND COVERAGE

Five-band models cover 20 / 17 / 15 / 12 / 10 m; six-band versions add 6 m. Every band is on a single 50 Ω feedline with no traps, no relays and nothing to switch. Two common variants: the broadband G3TXQ design favors bandwidth, the classic K4KIO design favors peak gain and front-to-back.

PROPAGATION IN PRACTICE

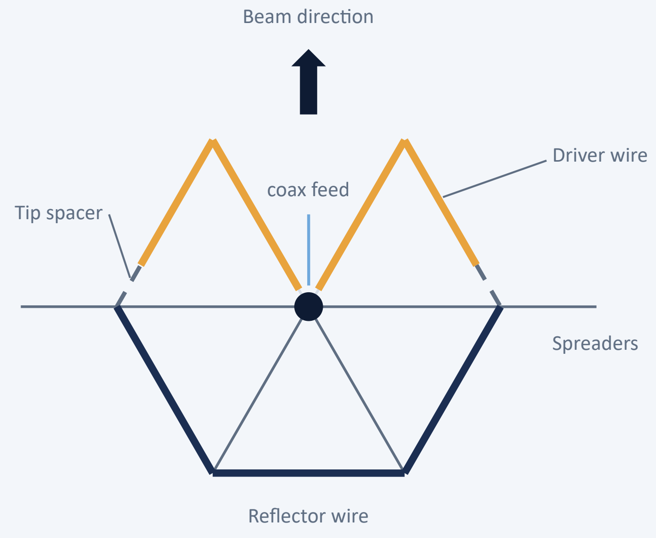
At 40 ft on 20 m the hexbeam is 0.6 λ up and radiates at roughly 20–25° — good DX, though not as low as a Yagi on a real tower. On 12 and 10 m that same 40 ft is 1.2–1.4 λ, and the takeoff drops below 15°. That is precisely why hexbeams look so spectacular during a solar peak: the higher the band, the better the geometry works for you.

STRENGTHS

- ≈ 5.5–6 dBd gain and 18–22 dB front-to-back on every band
- About 22 lb and 5 sq ft of wind load — a light rotator will do
- 22 ft turning radius fits a suburban lot where a Yagi never would
- One feedline, no traps, no loss, no switching — nothing to fail

TRADE-OFFS

- Less gain and front-to-back than a full-size monoband Yagi
- Wires and fiberglass spreaders degrade under UV and ice loading
- Still needs a mast, a rotator and a way to get it up there
- Assembly is fiddly; wire lengths and spreader tension both matter



Top view — driver and reflector on six fiberglass spreaders

Bands	20 / 17 / 15 / 12 / 10 m (+6 m)
Gain	≈ +5.5 dBd, F/B 18–22 dB
Weight	≈ 22 lb, ≈ 5 sq ft wind load
Turning radius	≈ 22 ft, single 50 Ω feed

The realistic upgrade path for anyone who wants directivity but cannot justify a tower. A hexbeam on a 30 ft push-up mast is a serious station.

Rotators and Rotor Control

A beam you cannot point is just an expensive dipole. Size it by wind area, not by antenna weight.

1 SIZING

Manufacturers rate rotators in square feet of wind surface area, not pounds. Derate by half in ice country. Hexbeam ≈ 5 sq ft (light duty). Tribander ≈ 10 sq ft (medium duty). Stacked monobanders ≈ 20+ sq ft (heavy duty).

2 CLASSES

Light: Yaesu G-450A, Hy-Gain AR-40. Medium: Yaesu G-1000DXA, Hy-Gain Ham-IV and Tailtwister. Heavy: Yaesu G-2800DXA, Prosistel, Alfa Spid, and surplus prop-pitch motors for very large arrays.

3 MECHANICS

Fit a thrust bearing above the rotator so it carries the vertical load and side thrust and the rotator only has to turn. Mast-mount for small antennas only; anything larger belongs inside a tower with the mast supported independently.

4 CABLING

Six to eight conductor rotor cable, heavier gauge for long runs. Voltage drop over 150 ft of thin cable is the usual reason a rotator stalls on a cold morning. Leave a generous service loop and proper drip loops.

5 COMPUTER CONTROL

Digital controllers such as the Green Heron RT-21 or Yaesu GS-232 add presets, soft start and stop, and calibration. A USB or serial link to N1MM+, PstRotator, Log4OM or DXLab means you click a spot on the bandmap and the antenna turns to the heading.

6 SET-UP DETAILS

Calibrate to true north, not magnetic. Set your end stops before the first full rotation. A 0–450° overlap model lets you swing through north without unwinding mid-contact. Check mast clamp bolts every spring.

Rotator failures are almost always mechanical or electrical, not electronic: check the mast clamp, the thrust bearing and the cable before you blame the control box.

Portable Operating — What Actually Goes in the Pack

POTA, SOTA, field day and travel. Two antennas beat one: a wire for the trees, a vertical for the parking lot.

End-Fed Half Wave

The default field antenna. One wire, one support, no tuner, no radials. A PackTenna Mini 40–10 m kit is under three ounces. Throw a line over a branch and you are on 40, 20, 15 and 10 m in five minutes.

Linked Dipole

Resonant on 40 / 30 / 20 / 17 / 15 m with nothing lossy in line — the best efficiency per gram in the pack, and the QRP operator's choice. The cost is lowering it to change a link each time you change band.

Chameleon

The MPAS Lite is a modular 17 ft whip that reconfigures as a vertical, a sloper or an NVIS wire. The CHA TDL builds an apex-down delta loop from two 17 ft whips and a 25 ft wire, 80–6 m with an ATU. Built like military hardware and priced to match.

PackTenna

Ultralight 9:1 random-wire and 49:1 EFHW kits on thin line with 26 AWG wire, in a pouch that fits a jacket pocket. The go-to when every gram counts and there is something to hang a wire from.

Portable Verticals

For treeless sites: a loaded coil under a telescoping whip on a tripod or spike, with four radials. REZ and Chameleon own this space and take opposite approaches — compared on the next slide.

Supports & Extras

A 20–31 ft telescoping fiberglass or carbon mast, an arborist throw line and weight, a drive-on or spike mount, and a short counterpoise. These are what actually determine how fast you get on the air.

Whatever you pack, bring a counterpoise and a choke. Field conditions punish an unbalanced feedline harder than a home station does.

Portable Vertical Systems

For the parking lot, the beach and the treeless summit. Two design philosophies — and that choice matters more than the brand.

REZ Antenna Systems

Resonant — tune the coil, leave the tuner at home.

Scout base

Multi-configuration feed point: ¼-wave vertical, coil-loaded vertical, dipole, end-fed or delta loop. 500 W SSB, integrated 4 mm radial ports.

Recon 40 II

40–10 m with the [Z]-17 whip. 500 W SSB / 200 W digital. A bypass switch drops the coil out so the whip is a plain ¼-wave up high.

Ranger 80 II

80–6 m with a whip of 9.3 ft or more. Sliding-tap coil, 200 W SSB / 100 W digital — note that is less power than the Recon 40 II.

Around them

[Z]-17 and [Z]-25 whips, [Z]Pod tripod, ground spike, [Z]QD radial kit, XForm 4:1 unun and the CM7 common-mode choke.

Trade-off: you reset the coil tap every time you change band.

Chameleon Antenna

Broadband — one transformer, let the ATU do the work.

MPAS Lite

17 ft MIL whip on a CHA Hybrid Micro transformer, spike mount and 25 ft counterpoise. Rebuilds as a vertical, sloper or NVIS wire. 100 W SSB.

MPAS 2.0

The full modular system — more configurations, higher power handling, and enough parts to build several different antennas from one kit.

CHA TDL

The same pair of 17 ft whips reconfigured into the apex-down delta loop covered earlier, or run as a ground-mounted vertical.

Coverage

1.8–54 MHz with a tuner, but genuinely efficient only where the whip is a decent fraction of a wavelength — think 30 m and up.

Trade-off: tuner losses on every band, worst on 80 and 40 m.

WHAT ACTUALLY DECIDES PERFORMANCE — AND IT IS NOT THE BADGE

Radials decide almost everything: four 33 ft wires is the practical minimum and eight is noticeably better · a coil-loaded whip is electrically short, so coil loss and ground loss dominate · fit a 1:1 common-mode choke at the feed point either way · 3/8-24 threads throughout mean whips, mounts and coils interchange across brands.

A loaded 9 ft whip on 80 m is a compromise however good the coil is. Expect it to work; do not expect it to beat a wire in a tree.

The POTA PERformer

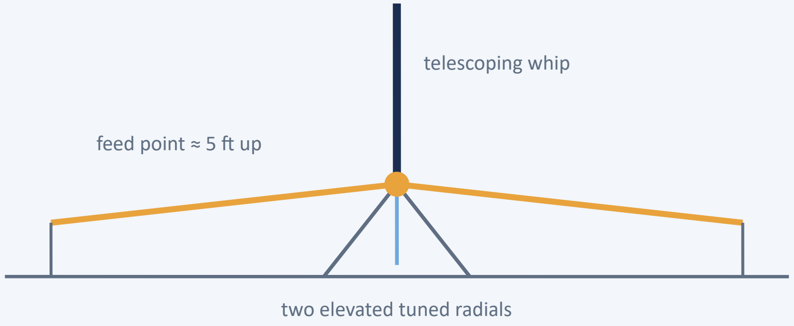
Portable, Elevated, Resonant — a homebrew quarter-wave that wins by getting its feed point out of the dirt.

BAND COVERAGE

20 through 6 m on the whip alone — set it to a quarter wave per band and cut the radials to match. For 40 m, add a base loading coil (KJ6ER uses a Wolf River Sport Forty). Modeled in 4NEC2; the published lengths land better than 1.1:1 with no tuner.

PROPAGATION IN PRACTICE

This slide is really about radials. A ground-mounted vertical wastes much of its power heating soil in the near field, which is why it wants 32–64 buried wires. Lift the feed point five or six feet and use two resonant elevated radials and most of that loss simply goes away — two elevated radials do the work of dozens of buried ones. Takeoff stays in the 20–25° DX window. Radials 180° apart give a clean omnidirectional pattern; 90° apart skews it and adds gain across that quadrant.



Elevated feed point on a tripod, two tuned radials (not to scale)

STRENGTHS

- Two elevated resonant radials outperform a large buried radial field
- Efficient enough that most users report it beating a ground-mounted vertical
- Cheap — a whip, a tripod, wire and connectors; the plans are free from KJ6ER
- Nothing lossy in the feed path: no unun, no tuner, no traps

TRADE-OFFS

- Band changes mean adjusting the whip and both radial lengths
- Radials at head height on a public site are a trip hazard — flag them
- 40 m needs a loading coil, which puts coil loss back into the system
- It is a set of plans, not a product — you build, tune and support it yourself

AT A GLANCE

Designer	Greg Mihran, KJ6ER — free plans
Bands	20–6 m whip only; 40 m with a coil
Feed point	5–6 ft up, tripod or long spike
Radials	Two, elevated and tuned per band
Related	POTA Dominator — 20–10 m half wave

Watch the name: Alpha Antenna sells a commercial vertical marketed as a "POTA Performer". KJ6ER's PERformer is a free set of plans, and the two are not the same antenna.

Feedline — Choosing Coax

Typical matched loss in dB per 100 ft. Figures are approximate and vary by maker — use them to compare, not to calculate.

Cable	3.5 MHz	14 MHz	28 MHz	50 MHz	Power @ 10 MHz
RG-58	0.9	1.8	2.6	3.6	≈ 500 W
RG-8X	0.5	1.1	1.5	2.1	1,000 W
RG-213	0.3	0.7	0.9	1.3	2,760 W
LMR-400	0.2	0.5	0.7	0.9	≈ 3,600 W
½ in hardline (LDF4)	0.1	0.3	0.4	0.5	> 10 kW

PICKING ONE

- Under 100 ft on HF almost anything works: 100 ft of RG-8X on 20 m costs 1.1 dB, about a fifth of an S-unit
- The same run on 2 m costs 3.8 dB against 1.5 dB for LMR-400 — that is where the upgrade earns its money
- RG-8X for jumpers, RG-213 or LMR-400 for the permanent run, hardline for long runs or high bands

WHY POWER RATINGS DISAGREE

Every rating is quoted at a frequency, and it falls steeply with it. Belden rates RG-8X at 1,000 W at 10 MHz but only 370 W at 50 MHz; RG-213 drops from 2,760 W at 10 MHz to 748 W at 100 MHz. Ratings also assume a matched load, rated ambient and a continuous carrier — and "RG-58" names a family of constructions, not one cable.

SWR MULTIPLIES LOSS

These are matched-loss figures: the floor, not what you get. Feed a 3:1 load and extra loss stacks on top, and that extra loss is heat in the cable. It is also why a shack tuner on a long lossy line is a poor plan — the tuner hides the mismatch from the radio, but the power still burns in the coax.

CONNECTORS, WEATHER AND BUYING

PL-259s are fine at HF; the failure mode is water, not loss. Seal every outdoor joint and leave drip loops. Bulk cable and your own soldering is cheapest, ready-made assemblies more reliable. ABR Industries of Houston builds American-made assemblies labeled with cable type, length, connector and lot number, and sells bulk coax, hardline and ground braid too.

Loss figures follow Belden catalog data for 8259, 9258 and 8267. Power is quoted at 10 MHz — above that it falls fast, and SWR cuts it further.

Chokes, Baluns and Ununs

The cheapest performance upgrade in amateur radio, and the one most often skipped.

THE PROBLEM

The outer surface of your coax shield will happily carry current back toward the shack. That current radiates from the feedline, distorts the pattern you designed, raises your receive noise floor with household electrical hash, and comes back into the operating position as RF.

BALUN vs UNUN vs CHOKE

A 1:1 current balun is a choke — it forces equal and opposite currents into a balanced load. Ununs (49:1, 9:1, 4:1) are impedance transformers for unbalanced loads and do not choke common-mode current at all. This is why an EFHW or random wire always needs a separate 1:1 choke in addition to its transformer. The same goes for the 4:1 voltage balun on a delta loop: it transforms impedance but chokes very little.

WHAT TO USE

- Eight to twelve turns of RG-400 or RG-316 on an FT240-31 core — the workhorse for 1.8–30 MHz
- Mix 43 performs better above about 10 MHz; mix 31 is the better all-band compromise
- Coiled bare coax (the "ugly balun") is band-specific and mediocre — use a real core
- Commercial units from Balun Designs, DX Engineering or Palomar are rated and worth the money

WHERE THEY GO

1:1 at every dipole, OCF and Yagi feed point · 1:1 about 0.05 λ down the coax from an EFHW or random-wire unun · one more at the station entry panel · bond everything to a single-point ground.

YOU HAVE A COMMON-MODE PROBLEM IF…

- You get RF burns from the microphone or key
- SWR changes when you touch the radio or the desk
- The tuner will not hold a setting, or retunes mid-transmission
- Your noise floor sits at S7 on a band that should be quiet
- USB devices drop out, or the computer locks up on transmit
- Audio distortion or feedback reported only on certain bands
- The antenna analyzer reads differently depending on where you stand

All seven have the same cure. Choke the feedline.

A common-mode current meter (or a clamp-on RF ammeter) turns all of this from guesswork into a measurement.

Grounding and Lightning Protection

The goal is not a good ground. The goal is that everything in the station sits at the same potential when a surge arrives.

1 SINGLE POINT ENTRY

Every coax, rotor cable and control line enters the building through one bonded panel. Ground rod at the panel, arrestors on the panel, and one heavy conductor from the panel back to the electrical service ground.

2 ARRESTORS

Gas-discharge or quarter-wave stub units from PolyPhaser, Alpha Delta or DX Engineering, mounted on the entry panel rather than behind the radio. An arrestor on a floating bracket does nothing — it works only through its bond.

3 BOND, DO NOT ISOLATE

A separate antenna ground rod that is not bonded to the service ground is worse than no rod at all: a surge lifts one ground relative to the other and the difference appears across your equipment. NEC Article 810 requires the bond for that reason.

4 TOWER AND MAST

Multiple rods at the tower base, spaced at least their own length apart, bonded with heavy copper and irreversible connections. Bond the tower back to the entry panel. Surge current will not follow sharp bends — keep runs short, straight and downward.

5 DISCONNECT

The cheapest and most effective measure there is: unplug the feedlines and physically separate them from the equipment when a storm is coming or you are away for the season. No arrestor beats an air gap.

6 BE REALISTIC

None of this survives a direct strike. The job is to shunt induced and nearby surges and equalize potential so the energy goes around your gear instead of through it. This is life safety as much as equipment protection.

NEC Article 810 covers antenna systems and Article 250 covers bonding. Codes change and jurisdictions differ — treat this as orientation, and involve an electrician in the service bond.

Side by Side

Typical figures for a competent installation. Gain is referenced to a dipole at the same height; takeoff angle assumes the height shown.

Antenna	Typical band coverage	Gain (dBd)	Takeoff angle	Supports needed	Effort
Half-wave dipole	One band + odd harmonics	0.0	15–60° (height dependent)	2	Low
Off-center-fed	80 / 40 / 20 / 17 / 12 / 10	≈ 0	Mixed lobes, band dependent	2	Low
Fan dipole	3–4 chosen bands	0.0	Per band, as a dipole	2–3	Medium
Linked dipole	40–15, one band at a time	0.0	Per band, as a dipole	2	Low
End-fed half wave	80 / 40 / 20 / 15 / 10	≈ −0.5	Mixed — sloper geometry	1–2	Low
End-fed random wire	160–6 with a tuner	−2 to −1	Unpredictable	1	Low
Delta loop	One band + harmonics	+1	15–25° fed for vertical pol.	1–2	Medium
Horizontal loop (skyloop)	Fundamental and every band above	+1 to +2	≈ 85° low band, 20–30° up high	4	Medium
Trap vertical (6BTV)	80 / 40 / 30 / 20 / 15 / 10	−1 to 0	20–25°	None + radials	Medium
Elevated vertical, 2 radials	20–6 m; 40 m with a coil	≈ 0	20–25°	Tripod, 5 ft up	Medium
Hexbeam	20 / 17 / 15 / 12 / 10	+5.5	20–25° at 40 ft	Mast + rotator	High
Yagi (3-el tribander)	20 / 15 / 10	+7.5	12–14° at 70 ft	Tower + rotator	High

Height beats gain. A dipole at 70 ft will often out-perform a hexbeam at 25 ft on a long DX path.

Choosing Yours

Start from the constraint you cannot change — space, supports, budget or a covenant — and work backwards.

One band, small lot, tight budget

A half-wave dipole, as high as you can physically get it.

Only one support available

End-fed half wave, with a counterpoise and a choke.

Quiet receive and DX on one band

A delta loop fed a quarter wave up from a bottom corner.

Directivity without a tower

A hexbeam on a push-up mast with a light-duty rotator.

POTA, SOTA and travel

An EFHW plus a linked dipole, and a portable vertical for treeless sites.

Many bands, one feedline

Off-center-fed or a fan dipole — and choke the feedline properly.

DX on 40 and 80 from a small lot

A vertical, and then spend the rest of the budget on radials.

A big yard and a regional net schedule

A full-wave horizontal loop: NVIS on 80 and 40, DX on the bands above.

Maximum performance, no compromise

A monoband Yagi on a tower, with a thrust bearing and a real rotator.

1. **Height beats gain.**
2. **On a vertical, radials beat everything.**
3. **Choke every feedline, every time.**

Not covered today, and all worth a follow-up session: magnetic loops for apartments and covenant-restricted lots · NVIS-optimized wires for regional emergency nets · receive-only beverages and loops · remote autotuners at the feed point · lightning protection and station grounding · antenna analyzers and the nanoVNA.