

Is an End-Fed Half-Wave a Good Antenna Compared with Other HF Antennas?

Measured evidence on efficiency and practical performance

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This review asks how much useful performance is gained or lost by choosing one common HF antenna system over another. It prioritizes controlled field experiments and measured component losses, and explains where the available numbers cannot support a complete antenna ranking.

Brief executive summary

The evidence does not establish a universal percentage advantage for EFHWs, center-fed dipoles, verticals, doublets, or OCF dipoles. The most defensible numbers describe a particular ground system, matching component, feed line, or direction of reception. Treating them as efficiencies of entire antenna families would overstate the research.

A measured EFHW matching unit achieved about 90–93% efficiency in a thermal test. That demonstrates that end feeding need not waste half the transmitter power; it does not establish the complete system efficiency or a fixed penalty relative to a dipole. [5]

Controlled 40-meter ground-system work found four elevated radials and 64 surface radials nearly equivalent in one installation. Other configurations differed by several dB. This is stronger experimental evidence for improving a poorly implemented vertical than for declaring all verticals better or worse than horizontal wires. [2]

Balanced-line doublets can have modest measured line loss, but the tuner and transformed load matter. One published tuner test lost 40% at a difficult 40-meter load despite a nearly perfect input match. Low SWR alone cannot identify an efficient system. [8,9]

Scope and evidence rules

Coverage is limited to amateur bands within 3–30 MHz, approximately 80 through 10 meters. There are no Yagis or directional arrays. The 160-meter band is outside this strict HF scope. A peer-reviewed 160-meter WSPR paper is listed only as a methodological lead, without importing its antenna results. [15]

Original experimental articles are distinguished from models, preprints, and operator reports. Commercial claims and forum anecdotes do not establish results. This is a focused critical review, not a systematic review proving that no other measurements exist. No website content was changed or published.

What the performance numbers mean

Quantity	Definition and proper interpretation
Radiation efficiency	Radiated power divided by power accepted at the antenna terminals. Define whether nearby earth loss is inside the antenna boundary.
Feed system efficiency	Power reaching the antenna divided by power entering the feed system. Includes line, transformer, tuner, and choke dissipation.
Total system efficiency	Radiated power divided by power at a stated station reference plane. Include mismatch or transmitter foldback explicitly, rather than silently changing the denominator.
Realized gain	Efficiency and directivity combined in a stated direction, including mismatch at the chosen reference plane.
Received signal and SNR	Signal strength and signal-to-noise ratio are different. Local noise, polarization, pattern, receiver settings, and propagation affect the result.
Reliability	Chance of meeting a stated communication threshold over specified paths and times. It requires repeated operational observations; it is not another name for efficiency.

For a passive system with a consistent accepted-power reference, total efficiency is the product of feed-system efficiency and radiation efficiency. In decibels, dissipative losses add. For a single-mode equivalent circuit, radiation efficiency is $R_{rad} / (R_{rad} + R_{loss})$, provided all resistances are referred to the same point. An input resistance measurement alone does not separate those terms.

Converting dB into percentages

For power, $A/B = 10^{(\Delta dB/10)}$. Relative change is $100 \times (A/B - 1)$ percent. For a positive loss L , the retained fraction is $10^{(-L/10)}$. Field-amplitude ratios use $20 \log_{10}$; power ratios use $10 \log_{10}$.

Difference A versus B	Power ratio A/B	Relative change versus B
+0.1 dB	1.023	+2.3%
+0.5 dB	1.122	+12.2%
+1 dB	1.259	+25.9%
+3 dB	1.995	+99.5%
-1.6 dB	0.692	-30.8%
-3 dB	0.501	-49.9%

These are mathematical conversions, not additional antenna measurements. A direction-specific 3 dB gain advantage means approximately twice the power received on that path under controlled conditions; it does not necessarily mean twice the total radiated power.

Moving from 80% to 90% efficiency is an increase of 10 percentage points, or 12.5% relative to the former 80%. Conversely, 80% is 11.1% below 90%. Always state the baseline.

Comparison of the available evidence

This matrix states what the reviewed evidence supports. It is deliberately not an antenna league table. References identify the original sources; study methods and limitations follow on later pages.

Antenna or system	Measured evidence available	What can be concluded
Center-fed resonant dipole	Reference in near-wire and on-air comparisons [7,12,19]	Useful comparison standard. No verified universal installed radiation-efficiency percentage in this source set.
EFHW	Thermal matching loss [5]; VNA methods [6]; near-wire current proxy [7]	Matching loss can be modest. These tests do not determine an all-band system efficiency.
Ground-mounted vertical	Controlled radial changes at fixed site [2]	Ground-system changes produce measurable signal changes. Soil and radial geometry constrain transferability.
Elevated vertical	Repeated surface-versus-elevated comparison [2]; multiband tests [4]	A few well-arranged elevated radials can work very well; sparse long radials can fail on another band.
Balanced-line doublet	Measured line attenuation [8]; tuner bench testing [9]	Low line loss is achievable. Complete efficiency depends on the actual line length, load, tuner, and balance.
OCF dipole	Balun component test [10]; QST design lead [16]	Measured matching loss exists. A controlled complete-system percentage advantage over EFHW or doublet was not established.
Trap dipole	Measured trap parameters followed by antenna modeling [11]	Useful conditional loss predictions; modeled antenna losses must not be relabeled field measurements.
T2FD and short loaded vertical	Simultaneous WSPR comparisons in a preprint [12]	Evidence about sampled paths, with pattern and receiver-distribution bias. Not absolute efficiency.
Fan dipole G5RV ZS6BKW random wire full wave loop	No adequate matched complete-system trial verified in this review	No percentage ranking assigned. Apply feed-loss, pattern, and installation analysis individually.

How much confidence to place in a result

Controlled relative field measurements are strong evidence for the tested alteration, especially when repeated and corrected for mismatch. Bench measurements are strong for the component and test load, with appropriate calibration. Near-wire sensing is a current-distribution proxy. Simultaneous skywave measurements describe useful path performance but add propagation and sampling assumptions. NEC predictions explain mechanisms; agreement with a field result does not turn every neighboring modeled case into a measurement.

Controlled experiments on 40 meter verticals

Common measurement method

Severns used VNA transmission measurements between a test antenna and a fixed receiving antenna, measuring feedpoint impedance as configurations changed. Most work was at 7.2 MHz. Feedpoint and transmission calibrations bracketed runs; low-loss coax reduced SWR-dependent cable loss. He reported short-term repeatability around 0.05 dB over two to three hours, but practical A/B accuracy of a few tenths of a dB. Temperature, wind, and site stability mattered. These were relative tests, without absolute pattern integration; groundwave remained significant. [1] Reported S21 ratios are kept as test-system signal comparisons here; a separate accepted-power correction was not verified for every plotted case.

Surface radials compared with elevated radials

At 7.2 MHz, a 33.5-foot aluminum vertical initially used 64 insulated 33-foot surface radials and a feedline choke. The count was reduced to four; then the four radials and antenna base were raised to 6, 12, and 48 inches. The full sequence was repeated on three different days. Relative to four surface radials, 64 surface radials yielded +5.8 dB and four radials at 48 inches yielded +5.9 dB. [2]

Configuration versus four surface radials	Measured change	Equivalent power ratio
64 surface radials	+5.8 dB	3.80× or +280%
4 radials and base at 48 inches	+5.9 dB	3.89× or +289%
Elevated versus 64 surface radials	+0.1 dB	1.023× or +2.3%

The 0.1 dB difference is below the practical comparison accuracy, so it is not evidence that elevation wins by a resolved 2.3%. The result supports equivalence for this arrangement. Raising the base also changes geometry. The later directional gain table in the same article is NEC modeling, not additional measured gain data. [1,2]

More radials and the effect of shortening the antenna

In a separate 7.2 MHz series, antennas were re-resonated as 0, 4, 8, 16, 32, and 64 surface radials were tried. The zero-radial reference was a four-foot ground rod with buried Heliac, not an isolated monopole. Soil was measured near 0.02 S/m and relative permittivity 30. Received signal was measured about 1.8 wavelengths away at roughly 8° elevation. From zero to 64 radials, reported improvements were about 2.6 dB for a quarter-wave vertical, 3.4 dB for a base-loaded eighth-wave, and nearly 6 dB for a mobile whip: approximately 1.82×, 2.19×, and 3.98× their respective baselines. Most improvement came by 16 radials. [3]

Those three curves have different starting antennas and baselines. Their increments cannot establish their absolute efficiencies or their performance relative to a horizontal dipole. The full-size test does not prove that every yard needs exactly 16 radials. [3]

Multiband verticals and installation sensitivity

One radial design does not behave identically on every band

Severns tested a remotely resonated SteppIR vertical at 7.2, 14.2, 21.2, and 28.5 MHz. Surface configurations included C2, four radials per band connected together, and C4, thirty-two 33-foot radials. C4 exceeded C2 by 0.9, 1.0, 0.8, and 0.4 dB respectively. That is about 23%, 26%, 20%, and 10% more received power relative to C2. [4]

For elevated tests with the base six feet high, eight 33-foot radials produced a 4.0 dB deficit at 14.2 MHz relative to C2: 0.398× the sampled power, or 60.2% less. Radial lengths, resonance, choking, and coupling matter; “eight radials” is not a sufficient specification. The article tabulates adjusted element heights and impedances. Independent run counts and confidence intervals are not supplied for every configuration. [4]

Sparse radial resonances

A separate experiment at 7.2 MHz used a fixed 34-foot vertical and four surface radials shortened from 33 to 18 feet, with additional tests using eight radials, ground stakes, and a re-resonated element. The work spanned three weeks. The initial four-radial case improved about 2.8 dB as the radials were shortened, approximately 1.91× or 91% more signal power relative to the original radial length. Measured soil conductivity was approximately 0.015 S/m with relative permittivity 30. Current probing supported a resonance-related loss mechanism. [14]

The surprising result is conditional: sparse radials close to soil can be electrically longer than their free-space dimensions suggest. It does not justify indiscriminately shortening dense surface screens or tuned elevated radials. The QST overview summarizes related rounds with improvements exceeding 3 dB; those values should not be substituted for the 2.8 dB initial QEX result. [14,17]

Missing sectors change direction as well as efficiency

In follow-up tests at 7.2, 14.2, 21.2, and 28.5 MHz, a full 32-radial, 33-foot surface fan was compared with partial fans. At 7.2 MHz a 90° missing sector gave −0.44 dB toward that sector, whereas a 180° missing sector gave −1.91 dB. These correspond to about 90.4% and 64.4% of the reference signal power, or losses of 9.6% and 35.6%. Orientation checks used left and right sectors. [18]

These are measurements in the receiving direction, not global radiated-power deficits. They show why a vertical should not automatically be treated as perfectly omnidirectional in an actual yard. Per-configuration duration and a statistical confidence interval were not reported. [18]

EFHW measurements and return currents

Thermal loss in one matching unit

Rondeau built a nominal 49:1 autotransformer with a five-turn primary and two FT114-43 cores. In an installed-antenna thermal test he used 50 W FT8 transmissions, averaging 21 W at 42% duty cycle for 30–33 minutes. A measured cooling time constant and estimated assembly heat capacity converted temperature rise to dissipated power. Reported results are below. Power measurement had roughly 20% uncertainty; that is not an efficiency confidence interval. This is an independent technical experiment, not a peer-reviewed comparative antenna trial. [5]

Band	Reported efficiency	Reported loss	Heat fraction
80 m	90.5%	0.43 dB	9.5%
40 m	92.7%	0.33 dB	7.3%
20 m	93.4%	0.30 dB	6.6%
10 m	92.9%	0.32 dB	7.1%

These results are encouraging for that unit, but omit radiator, earth, feedline, and other losses from a whole-station efficiency claim. Do not turn the decimals into unwarranted accuracy or apply them to every two-turn or differently packaged transformer. [5]

Why transformer tests can disagree

Koellen measured single transformers with characterized load resistors and a calibrated two-port nanoVNA over 3–33 MHz, plotting representative HF points. He documented 100 sweep points, three core formats, and tests with and without compensation capacitors. The resistor, fixture, mismatch, and transformer must be separated; an ideal-resistor assumption can even yield an impossible result above 100%. Back-to-back measurements describe a cascade and its internal load, not automatically a single unit feeding a real reactive antenna. Calibration and fixture repeatability were described, but a comprehensive uncertainty budget and sample population were not. [6]

A direct comparison that measured a current proxy

Huggins compared two 30-meter wires, one center-fed and one transformer end-fed, using a battery-powered transmitter attached directly at the feedpoint. Nominal power was about 150 mW into 50 ohms. A calibrated logarithmic detector and magnetic loop sampled near-wire fields at one-foot markings. Both SWRs were below 1.5. He inferred a 1.6 dB deficit for the EFHW, about 69% of the reference power or 31% less; a second transformer gave a similar result. [7]

This was not a far-field or integrated-efficiency measurement. Exact accepted power for both antenna loads, height and soil characterization, repeated-run statistics, and an uncertainty budget were not established. Transformer dissipation was proposed, not isolated. The instrument chassis and displacement current still provide an electromagnetic return; absence of a coax cable does not prove the absence of return current. [7]

Doublets and balanced feed systems

Measured line loss is useful but incomplete

Hunt tested 60 feet of nominal 450-ohm window line using a two-port VNA, mismatch correction, and calibrated-out chokes and leads. The line was suspended at least 24 inches above ground. Tests in a 50-ohm system intentionally imposed high SWR. Near half-wave line-length multiples, dry losses ranged from 0.42 to 0.73 dB; rainwater spraying gave 0.48 to 0.82 dB at slightly shifted frequencies. Those losses retain about 91–85% and 90–83% respectively. [8]

Detergent-assisted wetting produced 4.24–5.19 dB losses, retaining only about 38–30%; it was explicitly uncertain how representative that treatment was. Ordinary rain therefore cannot be equated to that worst case. These are line measurements, not efficiencies of a doublet or of all ladderline brands. Repeats and formal confidence intervals were not tabulated. Some line-resonance test frequencies fall just outside amateur allocations and are supporting bench evidence. [8]

A tuner can dominate the budget

Salas tested a Comet CAT-300 in QST with resistive loads and a NIST-traceable meter for input SWR. The measured HF results below show the fraction lost inside the test arrangement reported for the tuner. They are not a measured doublet installation and do not characterize every tuner. Load reactance, balance, and high-power temperature behavior can change the outcome. Per-load repeat counts and loss uncertainty were not reported. [9]

Band and resistive load	Reported power loss	Retained power	Equivalent loss
40 m 200 ohms	8%	92%	0.36 dB
40 m 5 ohms	40%	60%	2.22 dB
20 m 200 ohms	20%	80%	0.97 dB
20 m 5 ohms	45%	55%	2.60 dB

The 40-meter 5-ohm test still showed about 1.1:1 input SWR. Matching success is therefore not a loss measurement. At 40 meters the 92%-retaining case delivers 53.3% more power than the 60%-retaining case, using the latter as denominator; the efficiencies differ by 32 percentage points. [9]

Implications for a multiband doublet

A doublet is a center-fed wire used away from its fundamental resonance, usually through balanced line and a tuner. Changing frequency changes electrical length, current distribution, feedpoint impedance, and the impedance presented by the line to the tuner. Changing line length can improve the tuner load without improving the radiator itself.

A low-loss line helps, but high SWR and a difficult tuner termination can still matter. Check the actual complex impedance and balance on every band. A shack-end tuner does not eliminate feedline loss. The reviewed evidence supports this engineering approach; it does not establish that a doublet is a fixed percentage better than an EFHW.

OCF dipoles and other multiband wires

What has actually been measured for OCF matching

NA6O reports testing 4:1 Guanella baluns with mixes 52, 43, and 31. The lowest reported loss was 0.20 dB at 30 MHz using mix 52, equivalent to 95.5% transmission or 4.5% loss in that test. Core diameter was 2.4 inches, with roughly 9–11 turns suggested. However, the short article does not give enough fixture, termination, calibration, repetition, and uncertainty detail to treat this as a precision complete-system comparison. Thirty MHz is also just above the 10-meter amateur allocation. [10]

The 2008 K1BQT QST article is a further original design lead. Its indexed extract reports approximately 0.2 dB insertion loss per matching device through 14 MHz, but the full PDF could not be retrieved during this review. It is therefore not used to establish an OCF-versus-EFHW advantage. [16]

Feed location and system behavior

For an ideal thin wire with the same geometry, operating mode, and normalized current distribution, moving the feedpoint changes the impedance transformation needed, rather than creating extra radiated power. Actual feed systems can change that distribution. This is an electromagnetic interpretation, not a measured assertion that every end-fed, OCF, and center-fed installation has an identical pattern.

An OCF installation needs sufficient common-mode control for its asymmetric feed. A transformer ratio alone does not specify choking performance. Current on the outer coax can radiate, alter the pattern, conduct local noise, or cause dissipation elsewhere. Radiating feedline current is not automatically wasted power, but it makes the intended antenna harder to characterize. Similar boundary issues apply to EFHW counterpoises and shack wiring.

Trap dipoles

Rauch measured 7 MHz trap impedances and used those values in antenna models. An RG-58 trap had roughly 17.8 kilohms parallel resistance near resonance versus about 99.85 kilohms for one discrete LC trap. The associated dipole predictions included 1.6 dB total coax-trap loss near 40-meter trap resonance, compared with 0.24 dB for a different LC trap design: about 69% versus 95% retained for those modeled losses. These are model outputs informed by component measurements, not controlled field measurements of whole dipoles. [11]

Loss depends on trap placement, tuning, current, and component Q. The source also predicts much smaller losses away from resonance. It does not support “one dB lost per trap” as a universal rule. Equipment calibration, sample count, and uncertainty are not comprehensively documented. [11]

Multiband interpretation: an 80-meter half-wave wire is several half-wavelengths long on higher HF bands. EFHW, OCF, and doublet systems can develop multiple lobes and deep directional nulls even with low dissipative loss. Fundamental-band dipole similarity cannot be extended unchanged to every harmonic. This is supporting antenna theory, not a measured all-band gain ranking; test each band and desired direction separately.

Fan dipoles loops and hybrid feed arrangements

Fan dipoles, full-wave loops, G5RV and ZS6BKW systems, and tuner-fed random wires remain plausible site-specific choices. This review did not verify controlled full-system tests sufficient to attach family-wide efficiency percentages. A low SWR plot, DX contact, or commercial power rating is insufficient. T2FD termination loss likewise needs an explicitly defined operating frequency and power boundary.

On air comparisons and contrary findings

Simultaneous WSPR can improve a comparison

Zander's 2022 preprint describes simultaneous transmissions and pairs reports from the same receiving station and time slot. Its field examples compare a 2.5-meter loaded vertical with a larger vertical on 14 MHz, and a 25-meter T2FD with an inverted-V dipole on 7 MHz. Roughly 1,000 reports per one-hour experiment reduced to 150–200 valid comparisons from 15–35 receivers. Report scatter was about 3 dB; an example mean-error estimate was below 0.5 dB. [12]

That statistical precision does not include all systematic bias. Receiver geography and different radiation patterns can bias inferred efficiency; unknown arrival elevation and missing reports near nulls remain problems. The antenna figures are measured skywave comparisons, while the supporting T2FD NEC result is simulation. These preliminary experiments do not supply absolute efficiency or a calibrated EFHW-versus-douplet ranking. [12]

An EFHW and an upper and outer can trade places by metric

Krüger's 2025 simultaneous 50 mW WSPR test used same-slot common reporters on 20 and 40 meters, with transmitter agreement estimated within ± 1 dB. The 15.5-meter coil-loaded EFHW hung about 2.3–3.6 meters high. The upper-and-outer used 7.19-meter radiator and radial wires, a roughly 1.3-meter feedpoint, balanced line, and a Z-match. On 20 meters it transmitted 4.6 dB stronger on average, about 2.88 $\times$ the reported SNR power ratio under common-noise assumptions. The author says the "dipole" was 3.5 dB stronger on 40 meters; this appears to mean the EFHW, but the wording is ambiguous. [13]

Local receive SNR favored the EFHW by 9.2 dB on 20 meters and 5.4 dB on 40 meters. Feedline length was unfinished in the description, and a support partially collapsed during testing. Exact paired counts and calibrated receiver equivalence were not summarized. This is a transparent operator experiment, not an efficiency measurement. Its opposing transmit and receive outcomes warn against selecting a winner from only one metric. [13]

A vertical does not always win a DX comparison

Netting compared a 20-meter, 5.1-meter ground-mounted vertical with six mixed-length radials against a horizontal dipole at about five meters. Both used approximately 20-meter feeds of different types. Switched listening and reports generally favored the dipole, with more noise on the vertical. The report uses uncalibrated S-points, lacks paired sample counts and power-normalization evidence, and does not establish a numeric efficiency penalty. [19]

The later takeoff-angle advantages in that article are modeled and must remain separate from the observations. Its broad assertion that elevating radials generally cannot help is not supported by the controlled results reviewed here. Both reports can describe their own sites; neither justifies a universal vertical-versus-dipole ranking. [2,19]

Practical interpretation for AF4OZ

Use measured losses to build a budget

Illustrative calculation only: assume a 95%-efficient radiator, 93% matching efficiency, and a 0.5 dB feedline loss. The total is $0.95 \times 0.93 \times 10^{(-0.5/10)} = 78.7\%$, or about 1.04 dB below lossless. No reviewed experiment measured that assembled system. This calculation explains why a good transformer alone does not establish station efficiency.

If the competing system had the same radiator and feedline but a truly lossless matching device, the 93% unit would produce 7% less radiated power. The lossless one would produce 7.5% more relative to the 93% case. Real dipole chokes and tuners have losses too; their measured values must replace the ideal assumption.

Operating constraint	Reasonable engineering response	Evidence limit
A resonant wire fits at useful height	Use a center-fed dipole as the local comparison reference.	Reference choice is not proof of universal superiority.
End feeding makes a better installation possible	Measure the EFHW match loss and define its return path.	Higher placement may outweigh a small matching loss; no universal crossover value.
One wire must cover many HF bands	Evaluate a doublet or OCF by band, including the actual tuner load.	No verified all-band percent advantage in this review.
A vertical is the practical option	Improve a sparse or poorly distributed radial system; evaluate elevated radials where feasible.	Published radial counts are conditional on geometry, frequency, and soil.
Reception is noise limited	Compare local receive SNR as well as transmitted signal.	A stronger signal can arrive with proportionately more noise.

What remains unknown

There is no verified multi-site trial here that measures complete EFHW, OCF, doublet, resonant dipole, and vertical systems with a common accepted-power boundary, comparable height and footprint, complete angular coverage, and repeated seasons. Absolute ground loss for ordinary home installations is particularly difficult to separate from pattern and propagation effects.

The reviewed studies also do not establish comparative failure rates, years of service, or probability of completing contacts. Thermal tests inform power handling, but are not lifetime tests. Short WSPR trials do not quantify reliability over a solar cycle. Mechanical convenience, weather sensitivity, tuning range, and available supports should therefore be reported as practical considerations without invented reliability percentages.

A reproducible comparison worth doing next

The most useful next study for AF4OZ would compare the actual candidate installations, with a second controlled experiment to isolate feeding method. This is a proposed protocol, not a claim that such measurements have already been performed.

Separate two research questions

For feeding-method efficiency, keep radiator length, geometry, height, orientation, and wire constant while changing a carefully documented feed arrangement. Characterize the transformer, tuner, choke, and line independently at the relevant complex loads. Record accepted power at the same reference plane. A common dummy-load calibration does not guarantee identical delivered power into two different antenna impedances.

For practical station performance, allow each antenna its realistic installation. Then explicitly report that height, footprint, and pattern differ. This answers which system serves the site best, rather than claiming to isolate feedpoint location.

Record enough detail to reproduce the result

For every band record frequency, wire lengths and material, all heights, feed and counterpoise geometry, radial lengths and count, soil measurements or a clear absence of them, nearby conductors, feedline type and length, tuner settings, choking impedance, and measured common-mode current where possible. Save calibration files and the actual impedance at each power-reference plane.

Use a stable local field range to investigate controlled changes. State receiving distance, polarization, direction, elevation, groundwave contribution, detector calibration, and mismatch correction. Do not call a one-direction field measurement integrated radiation efficiency.

Use skywave data as a separate operational outcome

Run simultaneous sources at separable frequencies within the same band and use paired observations from the same receiver and time slot, or use rapid randomized A/B switching with one calibrated source. Swap sources and feed paths to expose equipment offsets. Check antenna coupling and intermodulation when antennas are close together.

Collect several days and repeated time windows, retaining raw observations, missing decodes, and weather notes. Report paired counts, unique receivers, path and azimuth bins, medians, mean dB differences, spread, and uncertainty. Correlated reports from the same receiver are not independent trials; use receiver/time blocks for error estimates. Predefine how decoding thresholds and missing observations are handled.

Measure local receive SNR with matched receivers or a calibrated switch, common bandwidth and gain settings, and source swapping. Record background-noise power separately. An antenna can improve transmit-path strength while local interference reduces receive SNR.

Define success before measuring it

Specify paths, bands, modes, power, and a communication threshold. Reliability is the fraction of scheduled attempts that meet that threshold, with uncertainty and observation duration. Publish operational reliability alongside, rather than as a substitute for, component efficiency and directional gain.

Conclusion on EFHW effectiveness

The reviewed evidence does not show that EFHWs are universally less effective, or that all these antennas are equal. A well-designed EFHW can be competitive with a center-fed half-wave at comparable height and geometry. That engineering expectation is not proof of identical performance; missing controlled comparisons do not establish equality. [5–7]

End feeding adds a matching transformer and requires a return-current arrangement. One tested EFHW matching unit was roughly 90–93% efficient, implying about 7–10% matching loss, not a measured whole-system penalty relative to a dipole. Feedline and tuner losses also affect competing systems. Return-path and ground losses depend on the installation; common-mode current can radiate and alter the pattern rather than simply become heat. [5–9]

EFHWs are most likely to be close to center-fed half-waves when their radiators, patterns, and feed-system losses are comparable. A poorer match, lower placement, or unfavorable surroundings can make one installation worse; easier end-fed support may allow a better installation. Verticals depend strongly on radials and soil, while doublets and OCF dipoles depend on their feed and matching systems. Height and pattern determine where power is useful, and local noise affects receive SNR separately. Compare complete installations on your bands and paths, without assuming a universal winner. [2–4,8–10,12,13]

Worked example for the AF4OZ installation

This hypothetical comparison uses your installation descriptions and equalizes the coax only. It is an engineering interpretation, not a measured controlled comparison. Both antennas are assumed to use 70 feet of Messi & Paoloni AIRBORNE 10 coax.

Feature	ZS6BKW	MyAntennas 75-10 m EFHW
Coax assumption	70 feet of AIRBORNE 10	70 feet of AIRBORNE 10
Radiator geometry	Approximately T-like, close to a flat top with slightly downward-sloping arms.	Main wire described as near vertical; top height and tilt are not specified.
Heights and feed	Assume the 15-foot connection is the coax-to-balanced-line transition and the radiator center is about 35 feet high. Balanced-line dimensions are not supplied.	Feedpoint about 15 feet high; 15 feet of wire to a ground rod. Choke described as “near the center”; its precise position and type are unclear.
Other unknowns	Balun details, separation, azimuth, and soil are unspecified.	Transformer implementation, separation, azimuth, and soil are unspecified.

Equal coax type and length remove one difference, but do not force equal feedline loss: antenna mismatch changes coax loss, and the ZS6BKW also has a balanced-line section. Tuner, transformer, balun, choke, return-path, and ground losses remain installation dependent. The ground-rod wire may carry RF and change the system; its entire current is not automatically dissipated as heat.

What to expect in use

On 40 meters, the ZS6BKW radiator around 35 feet high is a reasonable candidate for useful regional signals in directions broadside to its wire. The near-vertical EFHW may favor some low-angle DX paths, depending on its actual current distribution, surrounding ground, and return path. This is a pattern expectation, not a measured gain or efficiency advantage. A near-vertical wire operating on several harmonics is not guaranteed to have its strongest radiation at low angles on every band.

On 20 meters and higher bands, expect the result to change with direction and band as lobes and nulls develop. Neither antenna has a universal advantage. For your installation, a well-implemented EFHW is not expected to be dramatically less efficient merely because it is end-fed. The practical distinction may be which antenna puts more signal toward the station you want and provides the better receive SNR. No measured efficiency ratio or percentage advantage can be assigned to these two installations from the information available. Compare them by band and path before choosing a favorite.

My practical example

This practical example uses 201 NEC2C model runs. Practical result: in these scenarios, the hooked EFHW is the stronger low-elevation candidate on 75, 60, 40, and 30 meters; the ZS6BKW is the stronger high-elevation regional candidate on 75, 60, and 40 meters. On 20 meters the low-angle advantage is conditional. The ZS6BKW often gains the low-angle advantage on 17 through 10 meters, but its directional nulls can reverse an individual-path result. Individual-path results still depend on bearing and elevation.

Inputs and scope: this example accepts the published MyAntennas EFHW-7510-2K-Plus, NI4L ZS6BKW, and AIRBORNE 10 specifications as engineering inputs. Your EFHW matches the identified product without its pole-mount brackets; no electrical difference is assigned to the missing brackets. Manufacturer loss specifications are inputs, rather than independent tests of your unit. All results below are calculations, not field measurements. The approximately 100-foot apex and remembered 35-foot downward tail are explored through geometry alternatives. Both coax runs are 70 feet of AIRBORNE 10. Ground-rod behavior, choking, exact bearings, and installed matching losses remain incompletely specified. [M1,M4,M6]

Geometry and reference assumptions

Item	Baseline model and sensitivity cases
EFHW dimensions	130-foot main wire; feed at 15 feet; apex at 100 feet; final 35 feet slopes downward 45 degrees. Manufacturer nominal length is about 130 feet. [M1]
Geometric consistency	95-foot rising section spans an 85-foot rise and a 42.4-foot horizontal offset. Tail ends at about 75.3 feet, displaced 24.7 feet horizontally from the apex. A vertical rise would instead imply 120 feet total.
EFHW bend direction	Baseline tail folds back in the rising section's vertical plane. Sensitivity cases turn the tail forward or sideways, use 25- or 45-foot tails at 130 feet total, or shift the apex to 90 or 110 feet. A 120-foot vertical-rise case checks the geometry alternative.
ZS6BKW dimensions	Assumed 92-foot main wire, center at 35 feet and ends at 30 feet. Alternative wire lengths are 90 and 93.6 feet, with end heights of 25 or 35 feet. NI4L specifies about 92 feet of required space, not an exact measured wire length. [M6]
EFHW return path	Baseline uses an explicit 2-meter horizontal return wire at feed height. Alternative return wire descends to 0.15 meter above soil. Neither represents a measured ground rod or your unspecified choke.
Power boundary	Equal power accepted at the modeled wire source. Copper loss and modeled earth interaction are included; coax, transformer, balun, tuner, insulation, tree and house are excluded.

The model uses explicit alternative return wires because the buried ground-rod arrangement cannot be reconstructed from the available dimensions. These alternatives test sensitivity to the return path; the modeled source impedance is not fitted to your antenna.

Calculated results by amateur band

Gains are normalized to accepted wire power. The table averages linear power gain over all model azimuths at a fixed elevation, then converts back to dB. It compares directional coverage, not a prediction for a particular country or an average of WSPR reports. Positive differences favor EFHW; negative differences favor ZS6BKW. “Scenario range” varies geometry and return assumptions on average soil; it is not a confidence interval.

MHz	10 degree baseline dB	10 degree scenario range dB	60 degree baseline dB
3.85	+7.4	+6.4 to +8.0	-7.9
5.35	+5.1	+3.0 to +6.6	-4.7
7.15	+5.2	+3.7 to +7.3	-9.9
10.12	+5.6	+3.7 to +6.9	-2.2
14.2	+2.8	-0.8 to +4.0	+2.8
18.1	-0.9	-2.6 to +0.9	+4.5
21.2	-1.1	-3.2 to +1.2	-1.9
24.95	-4.1	-6.5 to -1.9	-1.0
28.5	-6.3	-9.3 to -4.8	+3.8

How large are the differences

At 7.15 MHz the baseline EFHW advantage in the 10-degree azimuth average is 5.2 dB, about 3.30 times the power gain, or 230% more relative to ZS6BKW. At 60 degrees the ZS6BKW advantage is 9.9 dB, about 9.8 times relative to EFHW. These ratios are calculated angular gains, not ratios of total efficiency. The geometry range preserves the 40-meter low-elevation preference, but its size changes with soil.

At 28.5 MHz the baseline ZS6BKW advantage in the 10-degree average is 6.3 dB, about 4.27 times relative to EFHW. Its 10-degree gain nevertheless ranges from roughly -14 to +9 dBi with azimuth, so the average does not guarantee a win along a null. Unknown antenna compass bearings prevent country-specific predictions.

Ground sensitivity at low elevation

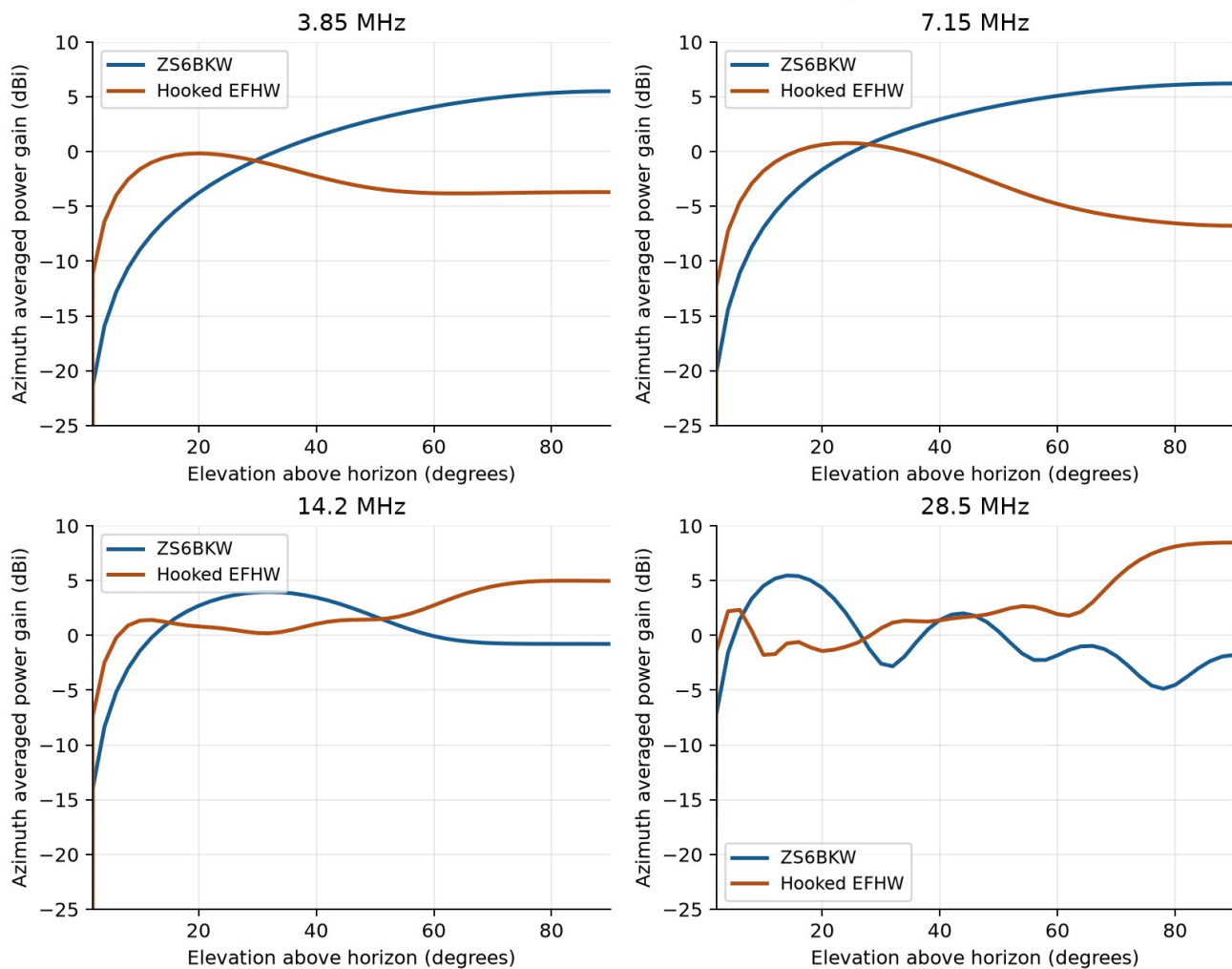
Frequency	EFHW minus ZS6BKW at 10 degrees over poor average good soil
3.85 MHz	+5.0 dB / +7.4 dB / +10.3 dB
7.15 MHz	+3.7 dB / +5.2 dB / +7.6 dB
14.2 MHz	+3.3 dB / +2.8 dB / +2.3 dB
28.5 MHz	-7.0 dB / -6.3 dB / -5.4 dB

Soil cases use relative permittivity and conductivity of 5 and 0.001 S/m, 13 and 0.005 S/m, or 20 and 0.03 S/m. They are assumed homogeneous flat soils, not measurements of your yard. The antennas were simulated separately; mutual coupling was not included.

Calculated elevation patterns

These curves show the baseline azimuth-averaged response over average soil. The EFHW is the 130-foot folded-back hook with the short horizontal return surrogate. The ZS6BKW has a 35-foot center and 30-foot ends. Transformer, tuner, and feedline losses would shift the corresponding curves downward.

Calculated elevation response at equal accepted wire power
Baseline bare wire scenarios over average soil

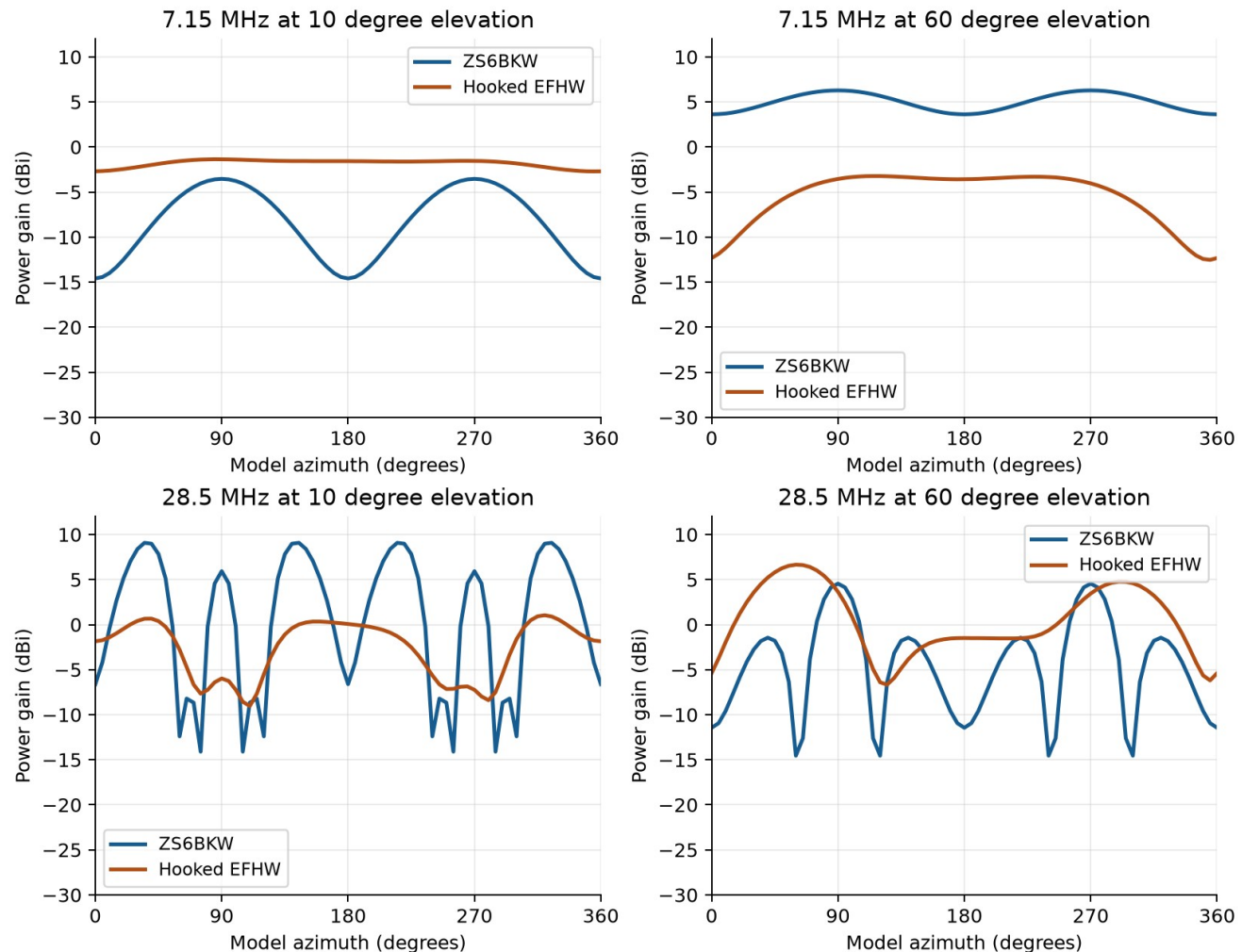


The most useful interpretation is the change with elevation: the 40-meter preference reverses between low and high angles. A taller structure does not automatically make every high-band lobe point lower. These modeled curves do not estimate the ionospheric arrival angle of an actual contact.

Calculated azimuth patterns

The horizontal model axis runs along the ZS6BKW wire and along the EFHW's rise-and-hook plane. Zero degrees follows positive x; 90 degrees is broadside to that plane. These axes were aligned for comparison only. They are not your measured compass orientations, and one antenna's actual azimuth plot may be rotated relative to the other.

Calculated direction dependence
Model axes are not compass bearings



At 40 meters, low-angle coverage is fairly uniform for this EFHW scenario, while ZS6BKW improves greatly at high elevation. At 10 meters both show directional structure. A contact in a deep null can favor the other antenna even when its all-azimuth average is lower. Receive SNR also depends on your local noise distribution, which this electromagnetic calculation does not model.

Calculated radiated fractions and feed losses

Product revision and matching loss

You confirmed the EFHW-7510-2K-Plus product page as your antenna, without its metal pole-mount brackets. It specifies 130 feet of 14 AWG XLPE-insulated wire and a MEF-130-2K+ transformer with three large cores. The specified 0.5 dB insertion loss corresponds to about 89% retained power in the transformer. The wire model uses an ideal source; transformer loss is applied separately when comparing station power budgets. [M1]

What the numerical efficiency calculation includes

The following fractions integrate calculated far-zone power gain over the upper hemisphere and divide by 4 pi. They estimate the fraction of accepted wire power escaping upward in each modeled environment, including copper dissipation and earth interaction. They are not transformer efficiency, not a measured total-system efficiency, and not the NEC printed “efficiency” field, which can omit earth absorption from its loss accounting. Surface-wave power at finite range is not the target of this skywave metric. [M2,M3]

MHz	ZS6BKW upward fraction	EFHW upward fraction	Interpretation
3.85	57%	31%	Average-soil baseline
7.15	77%	35%	Average-soil baseline
14.2	72%	68%	Average-soil baseline
28.5	72%	74%	Average-soil baseline

At 40 meters this model sends more total power upward from ZS6BKW, yet EFHW has more gain at 10 degrees because its power is distributed differently. This directly illustrates why an efficiency ranking and a DX-path ranking can disagree. The return-path and soil assumptions are too incomplete to label the tabulated fractions as efficiencies of your installed antennas.

Equal coax still leaves mismatch dependent loss

The manufacturer’s 20 °C AIRBORNE 10 attenuation table lists 1.0, 1.3, and 1.9 dB per 100 meters at 7, 14, and 28 MHz. Scaling to 70 feet gives the matched values below. The same sheet’s residual-power table is not numerically identical; the attenuation table is the consistent basis used here. [M4]

MHz	Matched line	Load SWR 3 to 1	Load SWR 10 to 1
7	0.21 dB	0.35 dB	0.97 dB
14	0.28 dB	0.45 dB	1.22 dB
28	0.41 dB	0.65 dB	1.69 dB

The SWR columns calculate accepted-input-to-load dissipation for a uniform 50-ohm line with the stated load SWR. They do not count reflected power as automatically lost. No actual antenna SWR was supplied. NI4L provides the balanced-line length, impedance and velocity factor; the measured wire load, line attenuation and tuner loss remain unknown. The 15-to-35-foot height difference does not determine how its 40-foot line is routed.

Matching section calculation for the NI4L antenna

Your identified NI4L product specifies 40 feet of FLEXI balanced line, nominal impedance 420 ohms and velocity factor 91.7%. It says about 92 feet of installation space, which is not an exact radiating-wire measurement. Baseline wire length is therefore assumed to be 92 feet, with 90 and 93.6 feet retained as alternatives. [M6]

The following circuit calculation takes the NEC baseline wire impedance and transforms it through the specified line using $Z_{in} = Z_0 (Z_L + j Z_0 \tan \beta l) / (Z_0 + j Z_L \tan \beta l)$. The first two result columns assume lossless balanced line. The final column instead assigns an illustrative 0.20 dB matched attenuation to that 40-foot section and calculates its actual dissipation with the same wire load. The 0.20 dB value is a sensitivity input because the identified page supplies no line-attenuation curve.

MHz	Coax load ohms	SWR to 50 ohms	Balanced line loss in 0.20 dB case
3.85	13 +108j	22.2	2.56 dB
5.35	1790 -946j	45.8	0.54 dB
7.15	63 -15j	1.4	0.64 dB
10.12	371 +1165j	80.7	0.96 dB
14.2	44 -38j	2.2	0.89 dB
18.1	75 -47j	2.3	0.55 dB
21.2	388 +1158j	77.0	0.92 dB
24.95	60 -70j	3.3	0.68 dB
28.5	109 -179j	8.4	0.46 dB

The 40-meter transformation is favorable in this approximation; 20, 17, and 12 meters are manageable but sensitive to exact dimensions and insulation. The very high 60, 30, and 15-meter loads show why a successful tuner match at the radio does not establish low feed-system loss. In particular, changing assumed wire length from 92 to 93.6 feet changes the 20-meter prediction substantially.

If the reported northwest-southeast direction describes the ZS6BKW span, its fundamental broadside directions are approximately northeast and southwest. Higher-band lobes are more complex; use the calculated angular plots rotated to that assumed wire axis. The EFHW plane and tail compass directions are still unknown, so a destination-specific comparison between the two antennas remains unresolved.

Transformer and tuner losses must be added separately. As a sensitivity example, an extra 1 dB of EFHW feed-system loss would reduce its 40-meter low-angle average advantage from 5.2 to 4.2 dB; it would not erase it in this scenario. On bands separated by only about 1 dB, unknown matching losses can reverse the result. No defensible total-system efficiency bound follows from the supplied dimensions alone.

Model checks limitations and reproducibility

Solver and numerical checks

201 NEC2C runs cover nine HF spot frequencies, baseline models over three soils, geometric and return alternatives, segmentation checks, and perfect-ground checks. NEC2C was built locally from source commit 55be1e0e3fe5ee9dad4ce6050711450d19c562fd. The engine incorporates the Sommerfeld ground solution; GN 2 selects it. All wires use radius 0.814 mm and conductivity 58 million S/m, approximating bare 14 AWG copper. [M2,M3,M5]

A free-space 10-meter wire at 14.99 MHz returned peak gain 2.17 dBi and impedance $79.4 + j45.3$ ohms, consistent with a thin wire at half a free-space wavelength, rather than a precisely resonant shortened dipole. The perfect-ground ZS6BKW hemispheric power integral was 0.9992; the EFHW value was 0.9354 with copper loss included. These are numerical consistency checks, not calibration against your field measurements.

Baseline segment length is at most 0.25 meter, with a 0.20-meter source segment. Repeating the two baselines at 7.15, 14.2, and 28.5 MHz with 0.125-meter segments changed azimuth-mean low-angle gain by at most about 0.16 dB and the hemispheric fraction by about 0.03. Coarser 0.5-meter runs were also checked. Pattern grids use 2-degree elevation and 5-degree azimuth spacing. Narrow null depths and exact peaks are less certain than broad trends.

What would materially improve the prediction

Confirm total EFHW wire length and which direction the 35-foot tail turns; measure the feedpoint-to-tree horizontal distance. Measure ZS6BKW wire length and both end heights, confirm its specified 40-foot line is unchanged, and clarify both antennas' compass bearings. Ground-rod dimensions, choke location and impedance, and measured antenna-side impedances are needed to constrain the feed and return systems. Tree contact, insulation and commercial compensation details were not modeled. Modeling both antennas together additionally requires their separation and relative orientation.

Primary sources for this calculated section

[M1] MyAntennas EFHW-7510-2K-Plus specifications, identified by the user. <https://myantennas.com/wp/product/efhw-7510-2k-plus/>

[M2] NEC2 theory, accepted-power gain definitions and far-zone ground fields. <https://www.nec2.org/other/nec2prt1.pdf>

[M3] NEC2 ground parameters and finite-conductivity loading. https://nec2.org/part_3/cards/gn.html

[M4] Messi & Paoloni AIRBORNE 10 datasheet, attenuation at 20 °C. https://messi.it/dati/immagini/AIRBORNE10-AII2_IT.pdf

[M5] NEC2C source and integrated Sommerfeld solver. <https://github.com/KJ7LNW/nec2c>

[M6] NI4L product dimensions and balanced-line specifications. <https://www.ni4l.com/zs6bkw-g5rv-optimized-multi-band-hf-dipole-antenna-poly-stealth/>

Which antenna should I use when making contacts

For higher-angle 40-meter regional contacts, try ZS6BKW first. For low-angle 40- or 30-meter DX, try the hooked EFHW first. At the modeled 3.85 MHz spot, likewise start with EFHW for low-angle DX and ZS6BKW for regional work; this does not establish a preference across the whole 80-meter band.

On 20 meters, try both because direction and geometry matter. On 17 and 15 meters, the modeled low-angle differences are small or change sign: start with the better received SNR. On 12 and 10 meters, try ZS6BKW first for low-angle DX, then switch to EFHW if a null weakens the station. For a difficult contact on any band, compare both quickly and request a transmit report. Choose the better two-way result, not receive loudness alone.

A beginner guide to choosing which of my antennas to use

For nearby contacts on 40 meters, try the ZS6BKW first. Nearby means stations in your state or surrounding states. Its stronger high-angle signal goes steeply upward and can return to Earth closer to you when the ionosphere supports that path.

For distant contacts on 40 or 30 meters, try the hooked EFHW first. Distant contacts are called DX and may be across the country or overseas. Its stronger low-angle signal leaves closer to the horizon and can travel farther before returning to Earth.

On 80 meters, the modeled 3.85 MHz example suggests the same starting choices: ZS6BKW for nearby contacts and EFHW for distant ones. This is a result at one frequency, not a rule for the entire band.

On 20 meters, try both. On 17 and 15 meters, start with whichever makes the other station easiest to understand above the noise. On 12 and 10 meters, try the ZS6BKW first for distant contacts.

These are starting choices for your installation, not guarantees. If a station is difficult to hear or reach, switch antennas and compare. Ask the other operator which antenna makes your voice or signal clearer. Use the antenna that gives the better conversation in both directions.

References and verification notes

Sources were reviewed on 28 October 2026. Numbers in the text are reported values or explicitly labeled conversions. Periodical dates below are the original publication dates, not search-engine crawl dates. URLs are clickable and printed for retrieval; DOI identifiers are supplied where established. No DOI was verified for the QEX and QST articles.

[1] Rudy Severns N6LF. Experimental Determination of Ground System Performance for HF Verticals Part I Test Setup and Instrumentation. QEX, January/February 2009, pp 21–25. Primary field-method paper.

https://antennasbyn6lf.com/ARRL_articles/QEX%20Jan-Feb%202009%20ground%20systems%20part%201.pdf

[2] Severns. Same series Part 3 Comparisons Between Ground Surface and Elevated Radials. QEX, March/April 2009, pp 29–32. See measured Figures 1–2; Table 3 is modeling.

https://antennasbyn6lf.com/ARRL_articles/QEX%20Mar-Apr%202009%20Ground%20systems%20part-3.pdf

[3] Severns. Same series Part 4 How Many Radials Does My Vertical Really Need. QEX, May/June 2009, pp 38–42. See experimental setup and Figure 2.

https://antennasbyn6lf.com/ARRL_articles/QEX%20May-Jun%202009%20Ground%20systems%20part-4.pdf

[4] Severns. Same series Part 6 Ground Systems for Multiband Verticals. QEX, November/December 2009, pp 19–24. Tables 3–8 identify configurations and measured changes.

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[5] Gary Rondeau. Engineering the EFHW 49:1 Transformer and Antenna. Squash Practice, 20 July 2021, updated 17 September 2023. Independent experiment; see thermal test table and uncertainty paragraph.

<https://squashpractice.com/2021/07/20/engineering-the-efhw-491-transformer-and-antenna/>

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<https://doi.org/10.48550/arXiv.2209.08989>

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[19] Steve Netting OH3SPN M0SPN. Vertical vs Horizontal HF Monopole vs Dipole. 24 September 2020. Operator observations followed by separate MMANA-GAL models; uncalibrated S-points are not converted into measured efficiencies.

<https://www.m0spn.co.uk/2020/09/24/vertical-vs-horizontal-hf-monopole-vs-dipole/>

Review limitations: search coverage included original technical websites, QEX and QST articles, and research-paper repositories. Full text was examined where retrievable; inaccessible items are labeled. No unpublished data, commercial marketing, or reader comments establish a quantitative conclusion. No matched multi-family RSGB or RadCom experiment meeting the requested controls was verified in this search. The original literature review involved no new simulations or field measurements; the later installation modeling is documented separately before these references.