Directional 160 & 80m Band Antennas:
Half-Quad, end-fed Inverted Vee, Half-Delta

Introduction:

Horizontal 'cloudwarmers' will not carry the signals beyond a few hundred km on Topband, the take-off angle is too high for DX. Only vertical polarization will yield real DX. To have an effective radiator on the low frequencies one does not need a full 1/4 wave tall radiator. Vertical half loops are about 1/8 wavelength tall, and can be made to work well at even lesser heights.

Small Is Beautiful:

A vertically polarized radiator does not have to be physically straight or vertical. These three examples are just over 1/2 wave long, and they are earthed at the far end, making them quiet on receive. All three examples require a good earth system at both ends. When scaled to the higher bands these antennas could be build atop a flat, curved or apexed metal roof.

From The Ground Up:

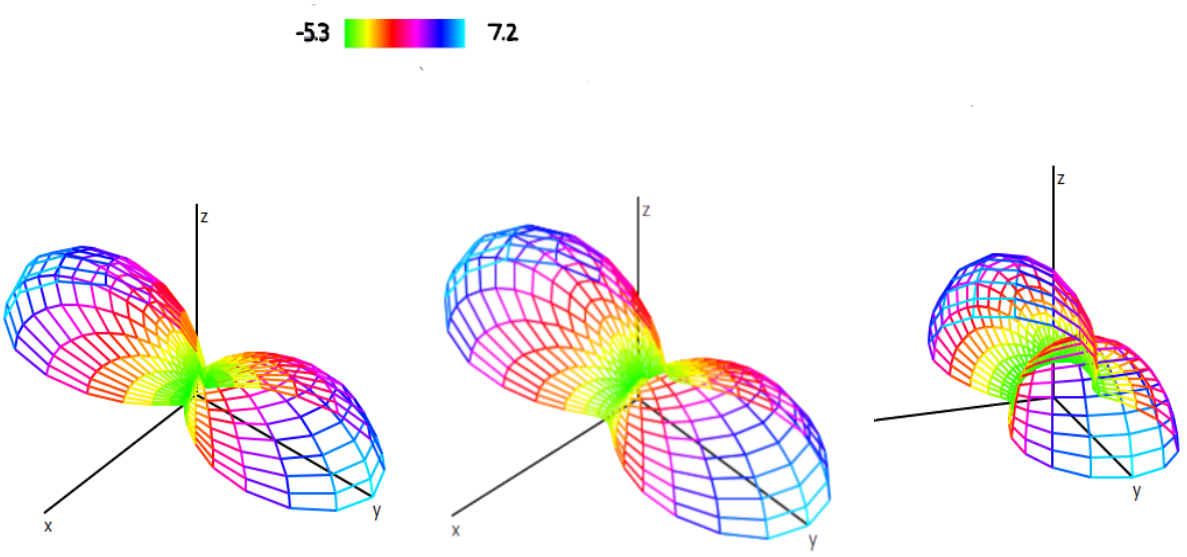
Imagine a radiator above a ground plane as candle standing on a mirror: as seen from afar one should see the candle directly, but also its reflection in the mirror. When the mirror is too small (short radials), or not reflective enough (too few radials and bad ground conductivity), not much of the reflected flame will be visible. The same goes for a good ground system: The signals at low angles will only be enhanced by ground reflections added to the direct path to and from the radiator when there is a well conductive ground around the base of the antenna, but also at a distance of it. To achieve this one needs to ensure that whatever current goes into the radiator should return to the feedpoint with the same magnitude from the ground system, gathered by the radials. Include everything that is conductive: metal roofs, fences, the deep well casing, coated or bare mats of chicken wire overgrown in the lawn. Tie in everything that is metal, except your car. Anything that is not connected acts as an unpredictable reflector at best, and as an an RF sponge at worst - not returning the collected ground currents back to the feedpoint.

How It Works:

Grounded half loops can be explained as a pair of 1/4 wave antennas connected tip-to-tip, or as a full wave loop with the bottom half beneath the ground. The impedance is typically four times as high as a single (loaded) vertical of the same height, or about half of an equivalent fullwave loop. Therefore one has two vertical sections, both radiating. The radiation from each element adds up broadside, and cancels out in the line of the elements, resulting in a figure eight diagram with a few dB of gain and deep nulls. Like all closed loops, the total length is a few percent longer than the calculated value. The colouring of the three diagrams at the top shows the antenna currents: red means high current, blue

denotes low current.

The polar diagrams of all three types are quite similar. These diagrams are calculated for an improbable ‘perfect ground’, since all NEC programs struggle with multiple earthing points. A more realistic gain is closer to 2 or 3 dB over single element with associated ground losses. Note the low take-off angle, and no high angle radiation – confirmed in daily use.



Half Quad Inv Vee Half Delta

Feeding the Beast:

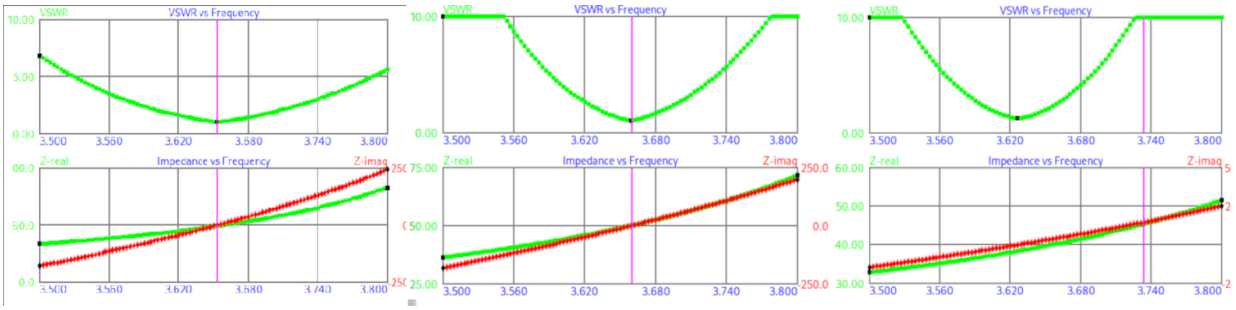
Depending on the ground conditions and the diameter of the vertical supports all three loop types have a feedpoind impedance of very close to 50 Ohms. A poor ground system will raise the feedpoint impedance somewhat, still well within the range of a typical 'line flattener' automatic tuners found in newer type transceivers. The dimensions of these prototypes for 80m are: a pair of 10 meter masts made with 42mm scaffold poles, 38 meters apart for the Half Quad, the tips connected with a pvc coated 2.5 mm diameter stranded copper wire. A pair of wires spaced 4 cm apart will drop the resonance frequency by about 50 to 60 khz, due to the larger top capacity.

The Inverted Vee apex is at 11 meters and has a total width of 46 meters. When a grounded steel mast is used as a support the resonance frequency drops by about 40 kHz, the impedance is also lowered to around 40 Ohms: the support becomes a part of the antenna. This is a real performance killer for centre-fed Inverted Vee antennas, especially when the enclosed angle is less than 120 degrees.

The Half Delta is 12 meters tall, using joined 42mm scaffold poles, supporting a 2.5 mm stranded copper wire. The low end at the far side is 'hitting the deck' at distance of 28 meters from the base, making the wire about 30 meters long. Fed at the base of the pole the impedance is close to 50 ohm, when feeding at the bottom of the sloping wire one needs to transforn the feedpoint impedance from close to 100 ohm to 50 ohm by using a 1/4 wave 75 ohm cable, made from about 17.5 m of cheap foam insulated satellite-tv cable. If that is not long enough to reach the radio, extend it with any length of regular 50 ohm cable.

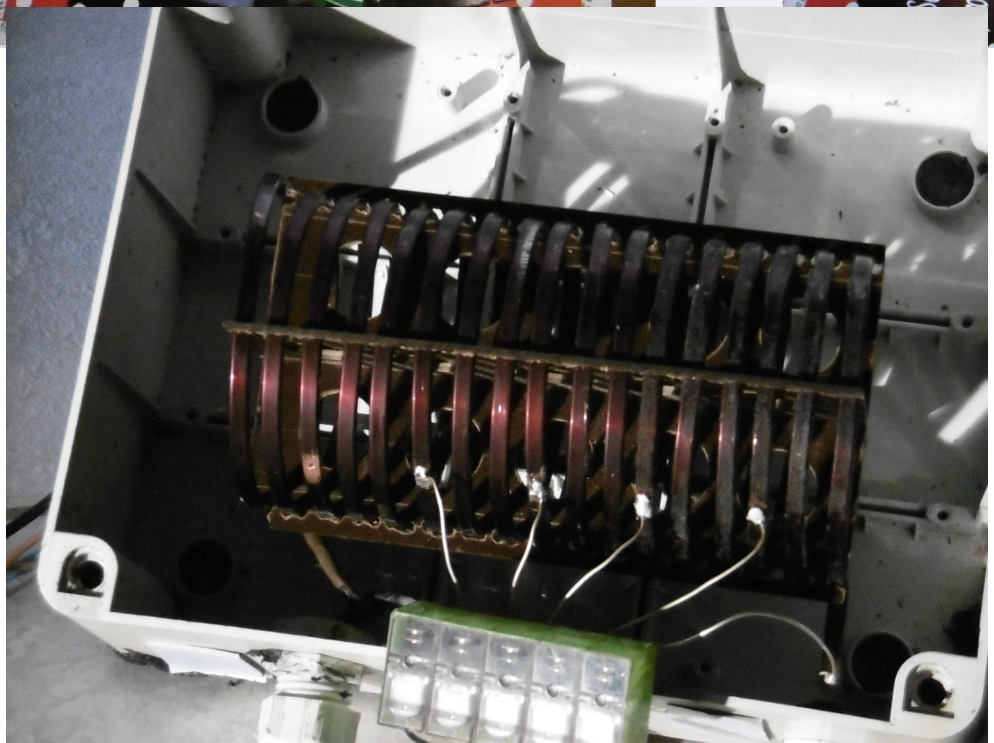
When using these designs on topband all dimensions are doubled, the resonance is at around 1850 kHz. I have built and used all three types for 80m and on Topband,they are proven designs.

The calculated SWR curves are very close to the measured curves over an extensive low-loss ground system at this QTH, the Half Quad with the largest possible aperture has the broadest pattern, a semi-circle would be even wider:



Half-Quad Inv Vee Half Delta

The SWR curve is broader than a regular 1/4 wave antenna, but still not enough to cover the entire 160 or 80m band. To get the whole band covered a roller inductor, or a tapped and switched loading coil is used in series at either end when the antenna is a bit too short. If it's made a too long a 500 to 800 picoFarad variable or switched set of capacitors brings it to resonace. A very broad low SWR curve is a sure symptom of excessive losses. Theses antennas are fed at one side against ground, the other end is grounded. A loading coil or capacitor can be inserted on either side, or both.



Images above: A homebrew tapped 12 microHenry coil, relais switched taps are at 2, 3, 5, 8 and 12 microhenry. This coil loads a 160m Half Quad, covering the full band. Made with flat 6x3 mm flat wire to keep parasitic inter-turn capacity low, on a pertinax coil former.

The Kicker:

Each of those half wave grounded loops can be used on it's first overtone: an 80m antenna will perform very well on 40m, vertically polarized with four main lobes and filled in nulls, and a small amount of horizontally polarized high angle radiation. The impedance on the first overtone will be about twice as high at the fundamental frequency, brought to 50 ohm with a 75 Ohm 1/4 wave line transformer or a 2:1 toroid transformer.

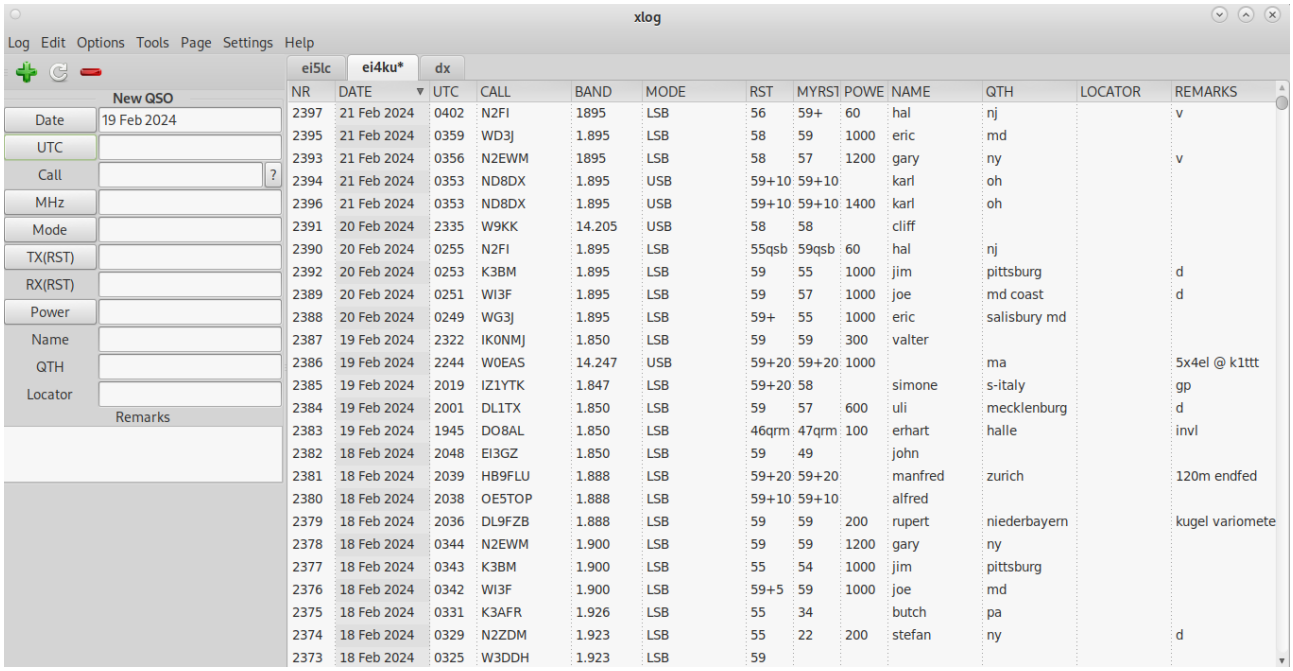
Automatic Tuners:

Using a remote ATU, e.g. a SGC Smarttuner makes the 160m versions truly useful for 160 to 30 meters. Shortened, capacity hat and/or loading coil resonated short endfed verticals all have a feedpoint impedance well below 50 Ohm, most tuners will struggle to provide a low-loss match, due to high currents in the coils in manual tuners. The relais in automatice tuners will burn out, due to excessive currents across the relais contacts. This does not happen with these type antennas.
note the discolored contact reed: it should be the same colour as the solenoid just below the red arrow. The result of passing too much current through the contact while trying to match a low impedance with a SGC230 at 100 Watt.

Conclusion:

During the past three years I built all of the classical Topband antennas, tested them, used them, then tore them down and recycled all those wires into a 2 hectare counterpoise.
I built various T antennas and Inverted L antennas, also investigating the influence of the support poles: Even at ~5 meters of distance the Inverted L is compromised due to the influence of the vertical support forming a partial open wire stub, quenching the vertical radiation. It can only work when the mast is insulated from ground or efficiently detuned.
A useful solution was to use the mast as part of a 'dogeared' Half Folded Dipole, providing a higher feedpoint impedance - but no overtone operation, and a lot of extra weight.
For the 2024 Topband Contest I even built a rickety full size vertical quad element, fed at the side. With the bottom wire too close to the ground it worked not as well as I hoped for, and the mechanical effort isn't worth it. What to to do with a well earthed mast,

set in concrete? Make it part of the antenna: I hit upon the half-wave loops, immediately outperforming all else, even with an initially poor ground system. With a vertical Half Quad I now work Topband SSB into North America and across Europe most nights, all on 10 watts SSB from a very basic Radio.



NR	DATE	UTC	CALL	BAND	MODE	RST	MYRST	POWE	NAME	QTH	LOCATOR	REMARKS
2397	21 Feb 2024	0402	N2FI	1895	LSB	56	59+	60	hal	nj		v
2395	21 Feb 2024	0359	WD3J	1.895	LSB	58	59	1000	eric	md		
2393	21 Feb 2024	0356	N2EWM	1895	LSB	58	57	1200	gary	ny		v
2394	21 Feb 2024	0353	ND8DX	1.895	USB	59+10	59+10		karl	oh		
2396	21 Feb 2024	0353	ND8DX	1.895	USB	59+10	59+10	1400	karl	oh		
2391	20 Feb 2024	2335	W9KK	14.205	USB	58	58		cliff			
2390	20 Feb 2024	0255	N2FI	1.895	LSB	55qsb	59qsb	60	hal	nj		
2392	20 Feb 2024	0253	K3BM	1.895	LSB	59	55	1000	jim	pittsburg		d
2389	20 Feb 2024	0251	WI3F	1.895	LSB	59	57	1000	joe	md coast		d
2388	20 Feb 2024	0249	WG3J	1.895	LSB	59+	55	1000	eric	salisbury md		
2387	19 Feb 2024	2322	IK0NMJ	1.850	LSB	59	59	300	valter			
2386	19 Feb 2024	2244	W0EAS	14.247	USB	59+20	59+20	1000		ma		5x4el @ k1ttt
2385	19 Feb 2024	2019	IZ1YTK	1.847	LSB	59+20	58		simone	s-italy		gp
2384	19 Feb 2024	2001	DL1TX	1.850	LSB	59	57	600	uli	mecklenburg		d
2383	19 Feb 2024	1945	DO8AL	1.850	LSB	46qrm	47qrm	100	erhart	halle		invl
2382	18 Feb 2024	2048	EI3GZ	1.850	LSB	59	49		john			
2381	18 Feb 2024	2039	HB9FLU	1.888	LSB	59+20	59+20		manfred	zurich		120m endfed
2380	18 Feb 2024	2038	OE5TOP	1.888	LSB	59+10	59+10		alfred			
2379	18 Feb 2024	2036	DL9FZB	1.888	LSB	59	59	200	rupert	niederbayern		kugel variomete
2378	18 Feb 2024	0344	N2EWM	1.900	LSB	59	59	1200	gary	ny		
2377	18 Feb 2024	0343	K3BM	1.900	LSB	55	54	1000	jim	pittsburg		
2376	18 Feb 2024	0342	WI3F	1.900	LSB	59+5	59	1000	joe	md		
2375	18 Feb 2024	0331	K3AFR	1.926	LSB	55	34		butch	pa		
2374	18 Feb 2024	0329	N2ZDM	1.923	LSB	55	22	200	stefan	ny		d
2373	18 Feb 2024	0325	W3DDH	1.923	LSB	59						

Sources consulted for this article which can be downloaded from http://ei4ku.ampr.org :
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