Reversible Balunless 10m Inverted-V ZL-Special for the Attic

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Introduction

Jeff Blaine, ACØC[1] Attic: 13m heigh directed north-south

Phased vs. parasitic

Most end-fire directional antennas obtain their radiation pattern from constructive and destructive interference of the radiation patterns

In

The advantages of a two-element phased array: - Can easily be made reversible because element lengths can be chosen equal, - A near-optimal element current ratio and phase results in a optimal front-to-back ratio, - Current forcing reduces the influence of nearby objects.[1]

First, the ZL Special, in any form, will have about the gain of a 2-element Yagi-Uda. In fact, most decent designs show about 6.1 dBi forward gain in free space, about the same as a two-element Yagi-Uda and about 4 dB better than a similarly placed dipole.

It provides a better than 15 dB front-to-rear ratio across the entire backside.

History

New-Zealand ham George H. Pritchard, ZL3MH (later ZL2OQ, now SK), brought the design to the attention of the radio amateur community in 1949, giving credit to W5LHI and W0GZR for basic information on the design.[2] It was eventually Fred C. Judd, G2BCX, developing variants from the earliest days onwards, who named the beam "ZL Special".

W7EL published a Field Day Special version of the antenna using equal length elements. reference design Roy Lewallen, W7EL

W7EL also noted a convenience: he attached half-wavelength sections of twin lead dangling from both the front and rear junctions. One just dangles (without touching the ground) while the other is connected either to the antenna tuner or the coax feedline. Swapping leads reverses the direction of the array. The dangling open-end half-wavelength line acts like a very high impedance, which affects antenna performance very little, if at all. Adjust these lines for the velocity factor of the ribbon cable, about .8 for most common 300-ohm twinlead.

> A personal favorite, the "Field Day Special" has been built on several bands and accounts well for itself from the home QTH as well as on Field Day. It was described in June, 1984 QST.[3] The elements are folded dipoles made from twinlead, connected by a half-twisted twinlead "phasing line". The elements are modeled as ordinary dipoles with a diameter equivalent to the effective diameter of the two-conductor twinlead. This is valid since the radiation properties of ordinary and folded dipoles are identical – only the feedpoint impedance is affected by the "folding" process, and only the pattern is being modelled here. The program used to design the original antenna wasn't entirely accurate so the element currents reported in QST weren't quite correct. The source currents in the model are the currents actually measured on the elements of a Field Day Special built to the dimensions shown in the QST article. This antenna has a respectable gain at low angles, a good f/b ratio, and a broad forward lobe. It's also quite forgiving. Constructed from twinlead, the input SWR is near unity. You can download the program used to design the "Field Day Special" from http://eznec.com.
>
> It would be difficult to model this using transmission lines because the elements are both transmission lines and radiators. Another problem is that the insulation makes the radiating portion appear about 3% longer while making the transmission line about 20% longer to the differential transmission line currents.

Crossfire phasing

Tom Rauch[4] The rear element current is lagging 315° (which is -45° leading) out of phase with the front element.

Reference design

Over the years L. B. Cebik wrote on several occasions about the ZL-Special. - 1997: The Poor Old ZL Special[2] - 1998: Don't Be Phased By Phasing[5]

In 2002 thoroughly analysed by L. B. Cebik[6] in the four-part series "Some Notes on Two-Element Horizontal Phased Arrays" - Part 1: The Limits of Performance - Part 2: The Limits of Geometric Phasing - Part 3: The Limits of a Single Phase Line: The ZL-Special - Part 4: Removing the Limits of a Single Phase Line by Element Matching

test

- 300Ω element: 16.26′ = 4.956m
- spacing: 4.27′ = 1.301m
- 300Ω phase line: 4.9′ = 1.494m
- 450Ω line: 18 AWG = 1.024mm; spacing 1" = 25.4mm
- 300Ω line: 20 AWG = 0.812mm; spacing 0.375" = 9.5mm

> using #18 wire at a 1" spacing (about 450 Ohms impedance as a transmission line and for #20 wire spaced 0.375" (about 300 Ohms as a transmission line. The longer length for the thinner wire, when taken individually and as a spaced 2-wire pair) is natural. The following notes are based on the 1"-spaced model. In both cases, using vinyl-covered wire shortens the physical element by 1-2% to account for the velocity factor of the insulation in antenna use.
>
> Although the element spacing is 4.27′ (0.1237 WL), the phase line is 4.9′ (0.1420 WL) long, despite the 0.8 velocity factor of high-quality twinlead. Indeed, calculations suggest that a higher front-to-back ratio results from the use of 340-Ohms line.

4nec2:

```
~/4nec2/models/HFActiveFeed/ZLTROM10.nec
~/4nec2/models/HFActiveFeed/zlspdp10.nec
~/4nec2/models/HFActiveFeed/ZLSPTS10.nec
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Inverted-V

Integrated balun

A 1973 British patent[7] shows how a folded dipole can easily be made self-balancing.[8(pp210-211)]

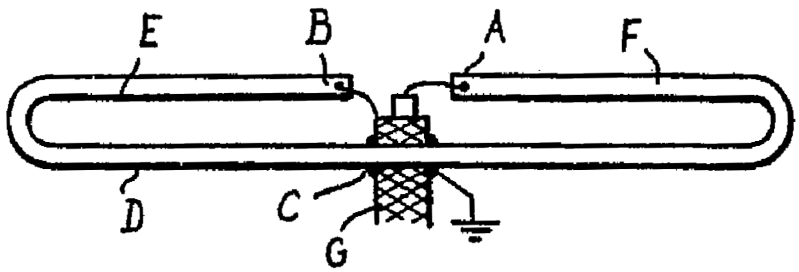

Figure 1: Self-balancing folded dipole with an integrated balun. *Source:* GB1322300

Modelling

- spacing 1.13m or 1.52m?
- impedance and length of spacing line?
- trim an element for resonance in the presence of the other element?

Parts list

Wireman reference

Table 1: Antenna

quantity	item	status
2	stainless-steel angle brackets	OK
2	50Ω N sockets, flange-type	OK
12	solder eye terminals ⌀4mm	OK
8	M?×? stainless steel bolts	measure
8	M? stainless steel compression rings	measure
8	M? stainless steel nuts	measure
2×5m	450Ω window-line, rated at 1kW	OK
1	phase line	calculate
4	straight 50Ω N connectors, compression-type	OK
?m	coaxial cable	OK
1	coaxial relay 50Ω 3× female N (e.g. Tothsu CX-600N, available from wimo.de)	order
1	diode	specify
?m	2 lead cable	measure
1	switch	find
1	switch box	buy
1	DC power cable	buy
1	small DC power connector	order

Table 2: Feed

quantity	item	status
1	brass entrance plate	order
3	straight 50Ω N connectors, compression-type	OK
1	angled 50Ω N connector, compression-type	order

Table 3: Test feed

quantity	item	status
2	crocodile clamps (without attached wire!) for shorting element ends	buy
?	BNC	

References

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7. Martin Thomas O'Dwyer. Improvements in or Relating to Aerials. Published online 1973. http://hamwaves.com/zl-special.10m/doc/GB1322300A.pdf

8. Alois Krischke, DJ0TR, Karl Rothammel. *Rothammels Antennenbuch*. 13th ed. DARC Verlag GmbH; 2013. http://darcverlag.de/Rothammels-Antennenbuch