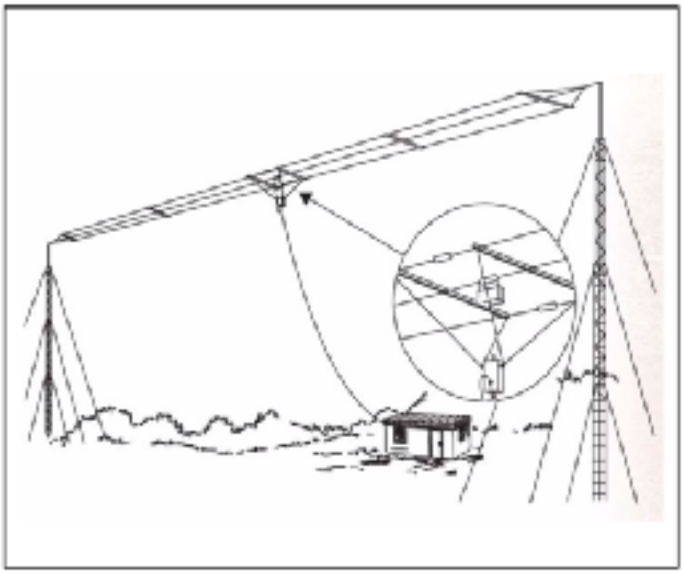
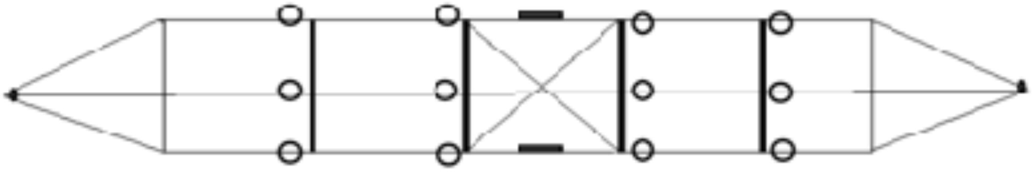
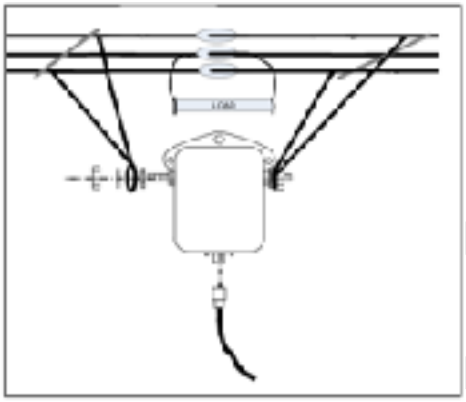
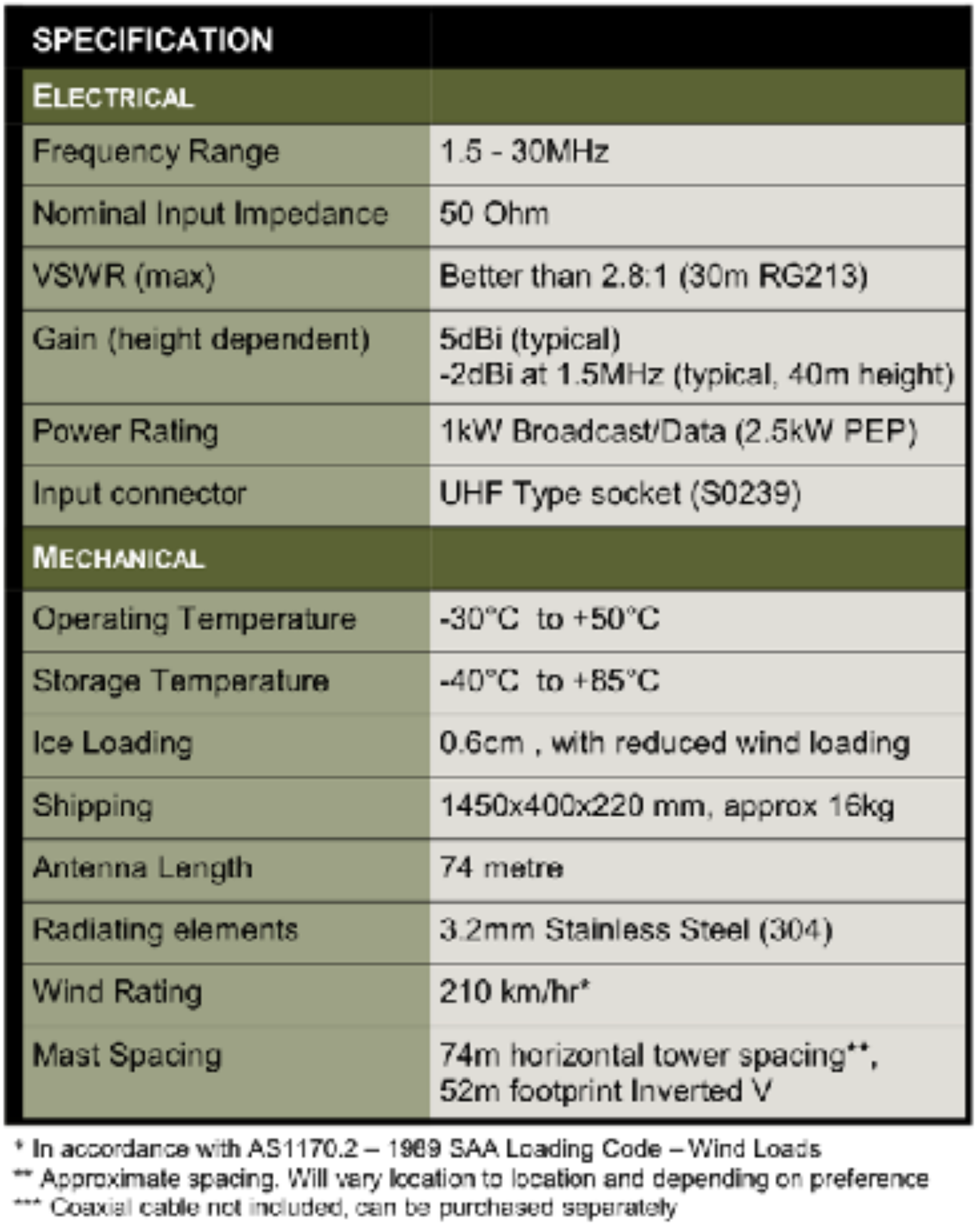
BushComm-3WIRE-EXPERIMENTS









SPECIFICATION	
ELECTRICAL	
Frequency Range	1.5 - 30MHz
Nominal Input Impedance	50 Ohm
VSWR (max)	Better than 2.8:1 (30m RG213)
Gain (height dependent)	5dBi (typical) -2dBi at 1.5MHz (typical, 40m height)
Power Rating	1kW Broadcast/Data (2.5kW PEP)
Input connector	UHF Type socket (S0239)
MECHANICAL	
Operating Temperature	-30°C to +50°C
Storage Temperature	-40°C to +85°C
Ice Loading	0.6cm , with reduced wind loading
Shipping	1450x400x220 mm, approx 16kg
Antenna Length	74 metre
Radiating elements	3.2mm Stainless Steel (304)
Wind Rating	210 km/hr*
Mast Spacing	74m horizontal tower spacing**, 52m footprint Inverted V

* In accordance with AS1170.2 – 1989 SAA Loading Code – Wind Loads
** Approximate spacing. Will vary location to location and depending on preference
*** Coaxial cable not included, can be purchased separately

FORWARD

The Bushcomm BBA-1KCF (and variants thereof) are a three wire version of the Terminated Folded Dipole. It is just about the best and most efficient example of this type of antenna that is available commercially.

It does not use a 50 Ohm resistor at the feed point. It does however use a 450:50 ohm Balun to feed the outermost two wires. These wires are connected at the far ends to the third centre(inner) wire which is "folded back" to almost meet in the middle where it is terminated on either half of the “dipole” with a 1200 Ohm resistor.

This effectively forms a terminated transmission line style type radiator, a bit like the Beverage design style antennae https://en.wikipedia.org/wiki/Beverage_antenna (1912) if you like, or a Travelling Wave Antenna. The original Bushcom antennae was a TF2 antennae which evolved into the 3 wire version installed around the world today.

The only time there is a significant amount of power dissipated in the terminating load resistor is at frequencies where the overall length of the folded dipole is less than a 1/2 wave of the operating frequency (I have seen .4 of a wavelength quoted). Some efficiency is being traded for a flattened SWR response across the whole frequency range in the selection of this terminating resistor, but the energy consumption is nowhere near as much as some folks would have you believe is being dissipated by the terminator.

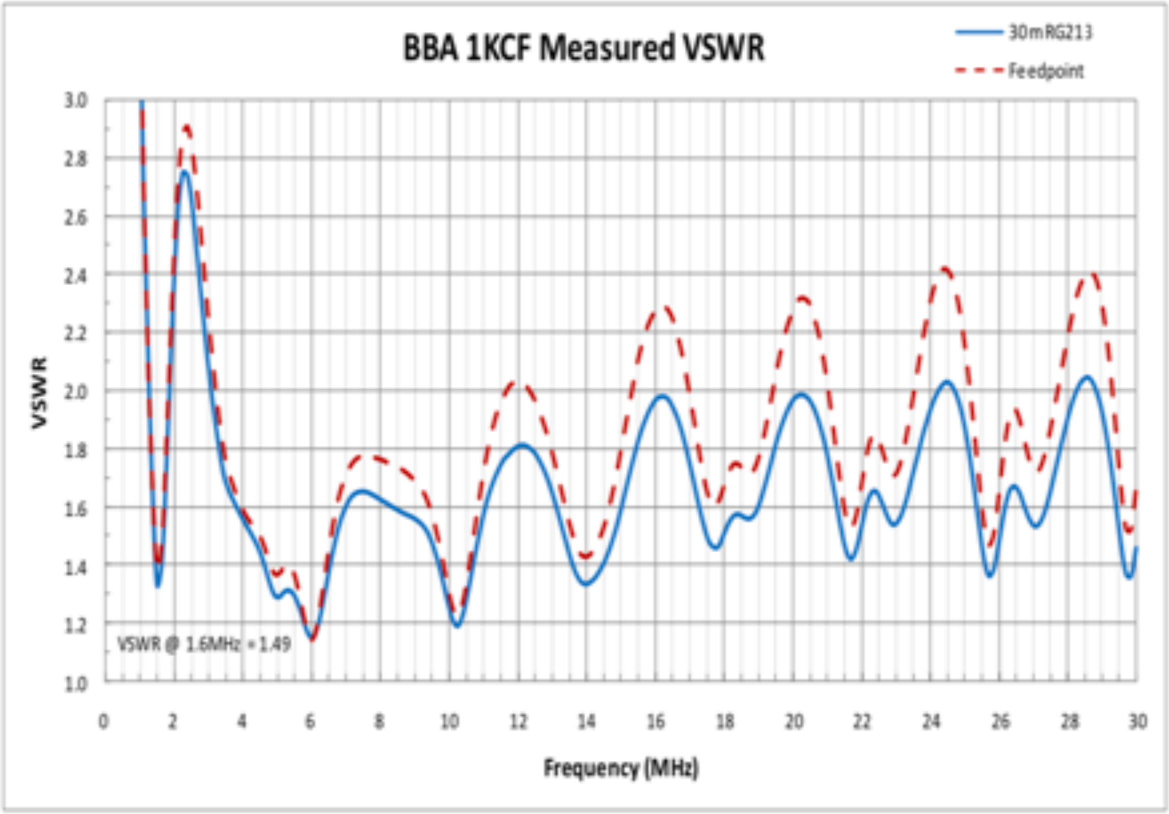
Note that a standard ladder-line fed Doublet when matched with a tuner, will easily have 2dB or more loss on some frequencies.

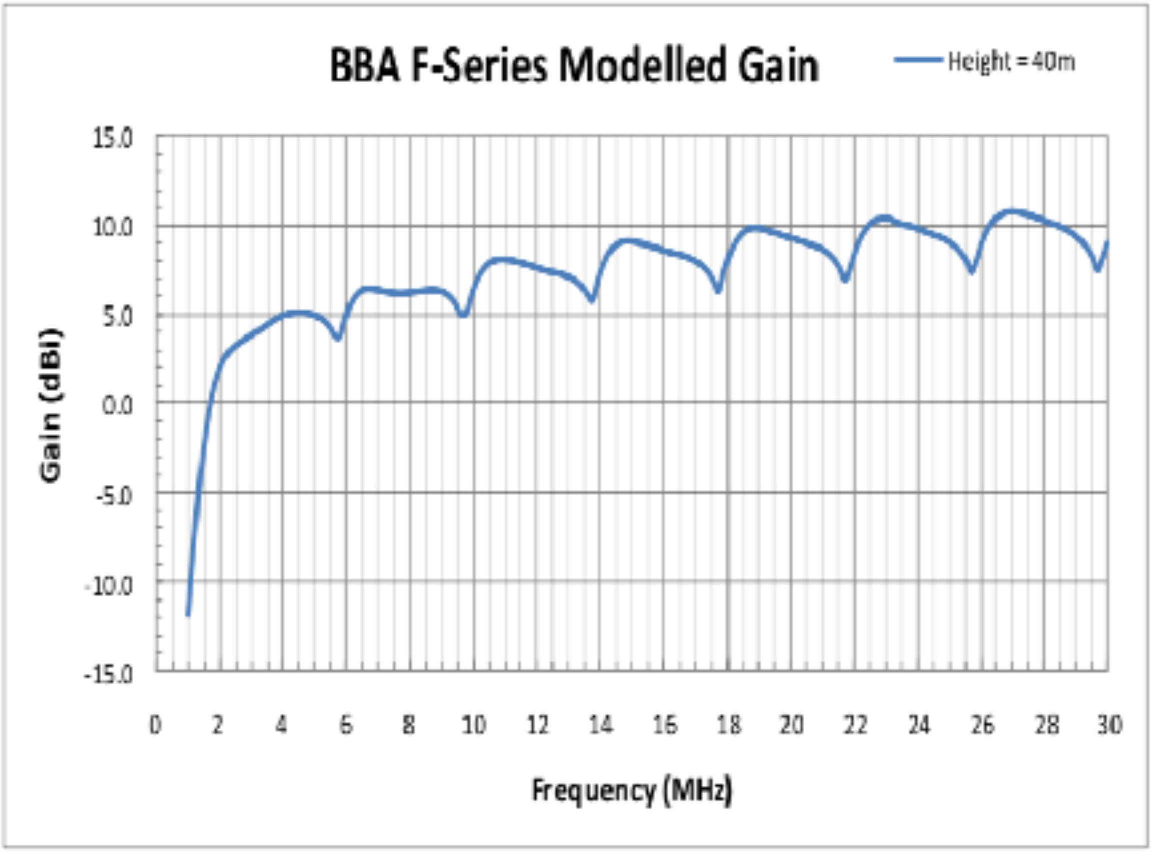
When compared directly with the Bushcomm BBA-1KCF and variant's to the design there is not a great deal of difference in performance on transmit if anything the BBA antennae performs above when reception performance is taken into consideration especially when comparing to the “standard Doublet”.

An aspect to be better quantified / verified is a direct comparison between terminated and un terminated antennae used in HF propagation and the improvements in signal to noise performance realised in using these types of "grounded" antennae, especially in rejecting man made noise. I think is is more in the order of a 6 -9 db reduction in resolved noise in the receiver or improvement in lowering the noise floor compared to an un terminated - un grounded antennae. Something that needs to be tested.

Think more commonly observed there are similar scaled to frequency improvements realised at VHF and UHF by using grounded folded dipoles for example, it seems completely reasonable to expect a significant reduction of man made noise and improvement for HF signal reception.

One aspect I am looking to investigate is in how to increase the field of capture / mutual reluctance coupling impacts, to realise greater energy transfer into the magnetosphere than other designs presently yield… What is the net improvement with a 5 wire version for example and any additional improvements to grounding the antennae.


BBA 1KCF Measured VSWR
30m RG213
Feedpoint
VSWR
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
VSWR @ 1.6MHz = 1.49
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Frequency (MHz)


BBA F-Series Modelled Gain
Height = 40m
Gain (dBi)
15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Frequency (MHz)

Reference Material

Broadband "Travelling Wave" Dipole

Based on a design by Dr. R.J.F. Guertier and G.E. Collyer, (1974 address) Antenna Engineering Australia (Pty) Ltd., Melbourne

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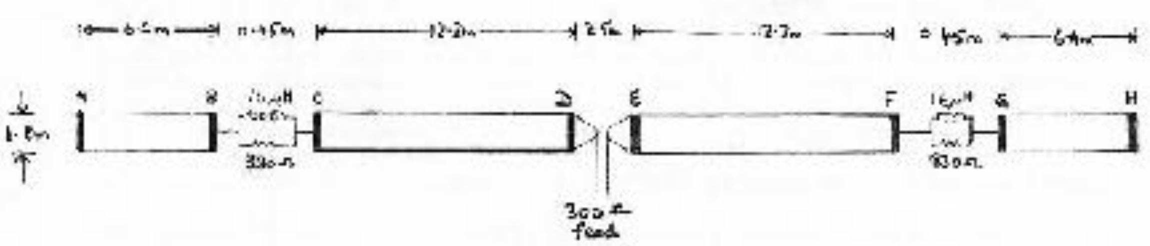
Quote from "Amateur Radio" - journal of the Wireless Institute of Australia - April 1974 edition:

"The authors presented a paper on this antenna at the recent IREE convention held in August 1973, in Melbourne. Further details are given in the Convention Digest which contains a two-page synopsis of all the papers presented. This digest is available from the offices of the IREE . . . Enquiries may be made by . . . writing to the IREE Melbourne Branch at 191 Royal Parade, Parkville, 3052."

Original Design:

"A dipole can be modified by inserting resistive loading networks so as to produce standing waves between the feedpoint and the networks. The authors have, by adjustment of the networks and the dipole sections, developed a travelling wave dipole whose VSWR is less than 2:1 from 3 to 15 MHz and does not exceed 2.6 to 1 from 2.3 to at least 30 MHz."



(A, B, C, D, E, F, G, H are 25mm dia. aluminium tubes.)

". . . neither the value of the 330 ohm resistors nor that of the shunt inductors was very critical. The shunt inductor has a small effect on SWR at the lower frequency end. However, reduction of the resistance to 150 ohms caused the SWR to fluctuate considerably with frequency. The taper sections were required to reduce shunt capacity between the spreaders D and E. reducing the length of this section produced an increase in SWR."

Elsewhere, (the ARRL Antenna Handbook), the resistors are specified as 2-5 watts rating for up to 500 watts pep. It is also recommended that the aerial should be at a height of at least 40ft (13m).

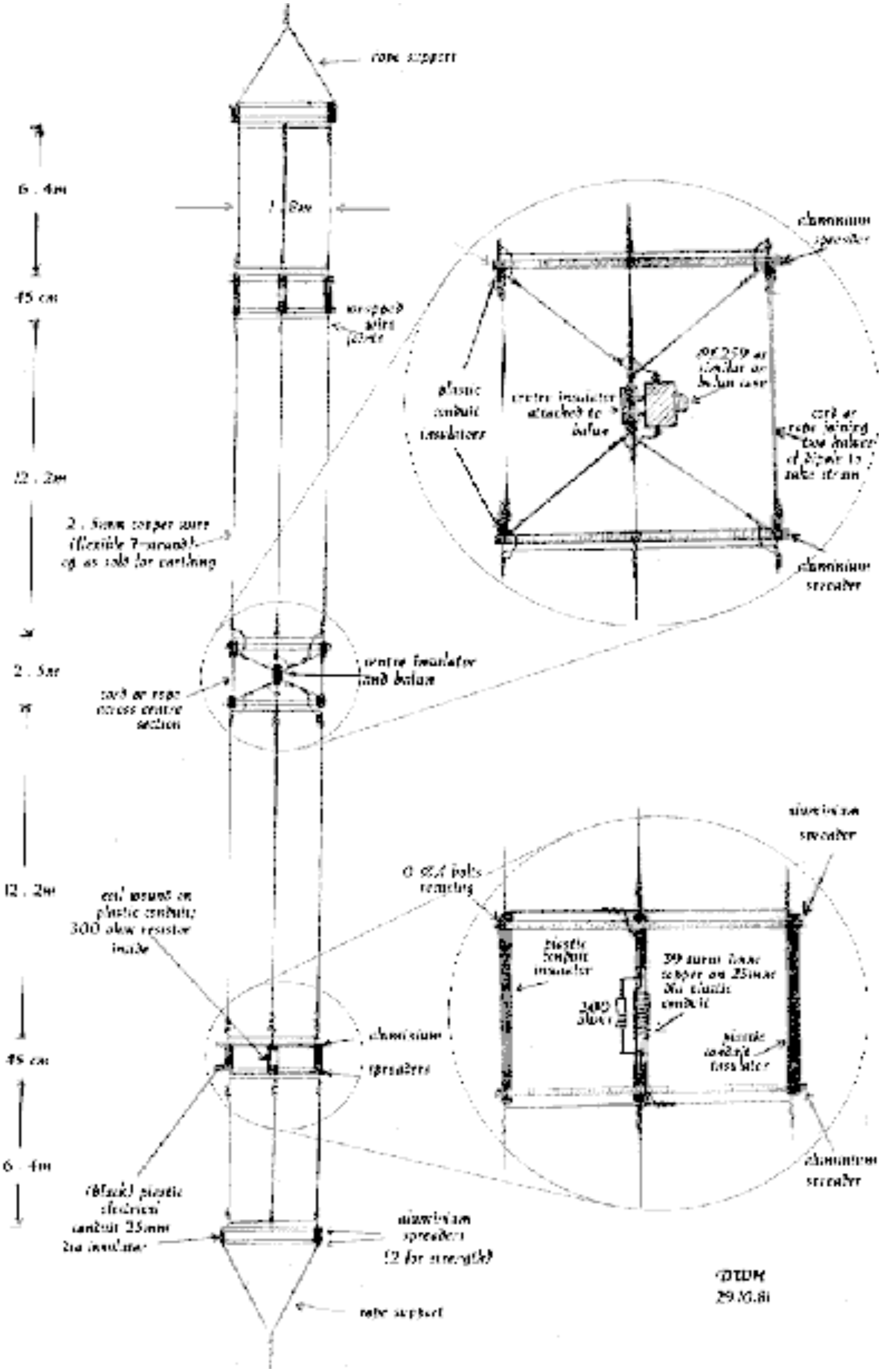
Several versions of this aerial were constructed, with varying degrees of success. The principal problem was high VSWR in the 5 to 8 MHz region. In an attempt to experiment with the shunt inductance, ferrite rod was inserted into the conduit upon which the coil was wound. It was found to be possible to adjust for low SWR at various places between 3 and 9 MHz, but clearly this would be a critical procedure in the field, and in any case, the problem was solved in a different way.

Modified Design:

An additional wire was run down the centre of the "tramlines". This dramatically reduced the fluctuations in SWR and virtually eliminated any critical adjustments. The height of the aerial seemed to have no effect upon its matching, although of course performance was changed slightly.

Details of the construction of the aerial are given in the diagram. A 5:2 matching transformer was wound on a standard 50mm toroid as shown.

Broadband Travelling Wave Dipole - constructional details


rope support
6.4m
1.8m
45 cm
wrapped wire joints
12.2m
2.5mm copper wire (flexible 7-strand) eg as sold for earthing
2.5m
centre insulator and balun
cord or rope across centre section
aluminium spreader
plastic conduit insulators
centre insulator attached to balun
SO239 or similar on balun case
cord or rope joining two halves of dipole to take strain
aluminium spreader
12.2m
coil wound on plastic conduit; 300 ohm resistor inside
aluminium spreaders
45 cm
6.4m
(black) plastic electrical conduit 25mm dia insulator
aluminium spreaders (2 for strength)
rope support
0 BA bolts retaining
aluminium spreader
plastic conduit insulator
39 turns 1mm copper on 25mm dia plastic conduit
300 Ohms
plastic conduit insulator
aluminium spreader
DWM
29.10.81

Broadband dipole - constructional details

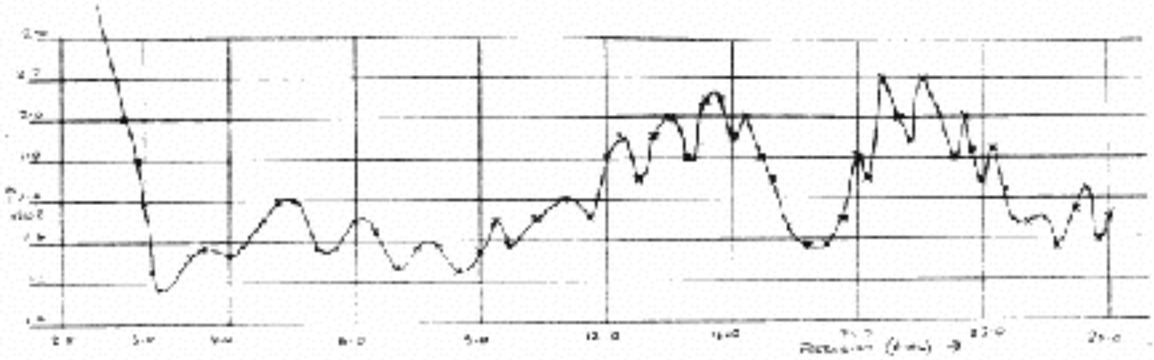
With the exception of the toroid, all materials were obtained locally. Approximately 100m of 7-strand, 2.5mm overall dia. copper wire was used, as sold for earthing in domestic installations. It was found convenient not to use the PVC insulated type, which simplified the wire-wrapping. Cheap, black plastic 25mm electrical conduit was used as a coil former and to make the insulators. The aluminium spreaders were very simply made, using decorative aluminium strip approximately 25mm wide and about 10mm thick, formed as a half-"U" and sold for fronting formica table-tops and the like. Ordinary 0-BA bolts were used to hold the various strips and tubes together.

Because of past experience of ultra-violet damage to rope and plastics, some care was taken to select the appropriate materials. Black conduit was used because of its resistance to UV, and the aerial was suspended with ordinatry fibre rope rather than nylon. However, it appears that fishing stores may be also be a good source of ultra-violet resistant polyester or similar rope.

The performance of a typical, unadjusted, aerial/transformer combination, with approximately 25m of 50 ohm coaxial feeder, is shown in the diagram. The aerial was suspended at about 40 feet.

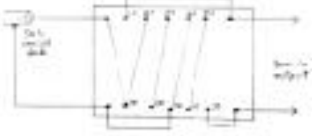
Measured Performance

Wideband Dipole, VSWR against frequency

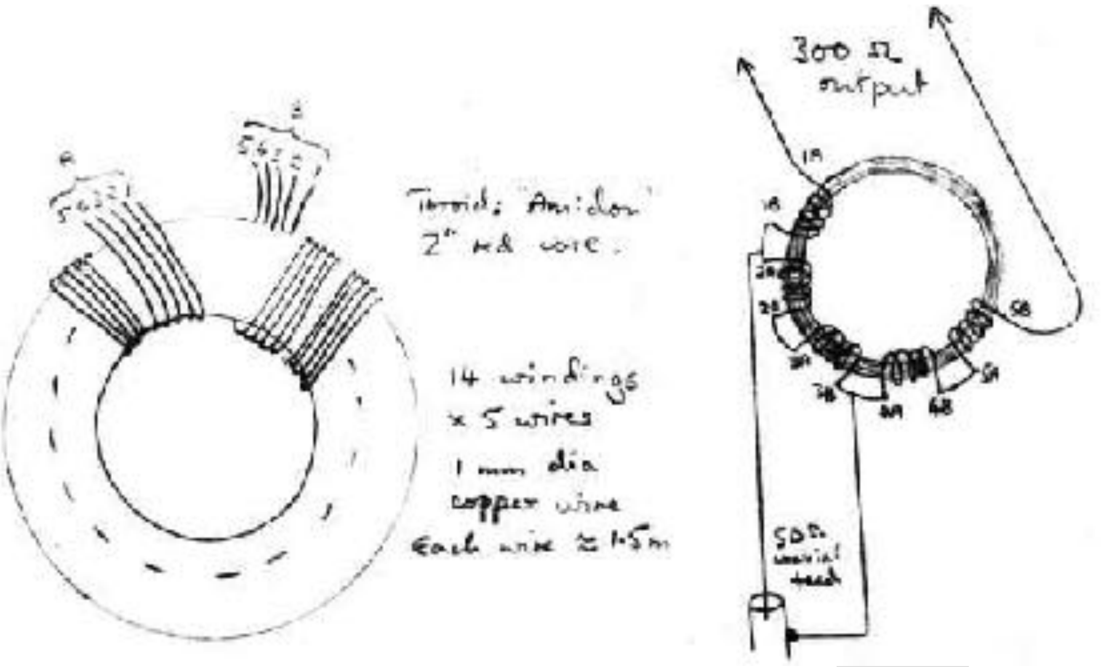


Constructional Details

5:2 Broadband transformer



5:2 wideband transformer wiring diagram



Toroid connections

More on the T2FD

CAPT. G. L. COUNTRYMAN, U.S.N., W3HH

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"An Experimental All-Band Nondirectional Transmitting Antenna" by Gil L. Countryman, W1RBK, (W3HH), QST, June 1949, page 54

An Experimental All-Band Nondirectional Transmitting Antenna

1949

Some Possibilities Offered by the Tilted Folded Dipole

BY G. L. COUNTRYMAN,* W1RBK, W3HH

FEW improvements in antennas for the lower-frequency bands have been forthcoming for several years. The arrangement to be discussed is not entirely original with the author but was based on some Navy antenna studies. Initial tests indicate that it may provide an acceptable solution to amateur multiband operation.

Briefly, it is an aperiodic system that will give uniform output over a frequency of approximately a 5-to-1 ratio with nondirectional characteristics and without critical adjustment. In fact, the only adjustment is to couple the final tank to a 600-ohm line.

The practical experiments conducted by the author are incomplete, but it is hoped that the publication of the data contained herein will encourage experimenting by other amateurs. There are many questions unanswered, measured variation in standing-wave ratio over a given frequency range, loss in power attributable to the resistance termination, experimentally-obtained radiation patterns, etc.

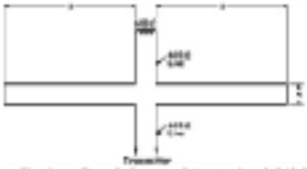

Fig. 1 — General diagram of the terminated folded dipole. Dimensions for A and B are suggested in the text.

Essentially, the system shown in Fig. 1 is a terminated folded dipole. It is fed with a 600-ohm line. This antenna, if horizontal, will be quite directional at right angles to its axis, with pronounced minima off the ends. As the antenna is tilted with respect to ground, this pattern gradually changes until at an angle of 30 degrees it becomes nondirectional for all practical purposes. Translated into terms of amateur construction this means that only one mast is required, together with a short pole six feet or so in height supporting the low end. There seems to be no marked advantage in an increase in over-all height of the antenna. On the contrary, reports from a distance indicate that signals are definitely better with one end of the antenna only six feet from the ground, perhaps because of a resulting lower angle of radiation.

> **• These hams who are experimentally inclined will no doubt be interested in the possibilities that this antenna system suggests. Practical tests by the author have show that the single antenna may be operated over a frequency range as great as 5 to 1 with a relatively small change in the standing-wave ratio on the line and that the pattern is essentially nondirectional.**

Because complications are introduced by the resistance termination, it is difficult to make an adequate analysis or evaluation of a terminated folded dipole by conventional methods. It becomes necessary to measure performance experimentally.

One of the Navy laboratories has investigated the performance of this type of antenna and has reported favorably upon it. However, the laboratory study was based upon a vertical monopole erected over a metallic ground plane, using conventional measuring instruments, and the characteristics obtained were applied mathematically to arrive at theoretical characteristics for the resistance-terminated folded dipole. Operational tests were not made by this laboratory and their theoretical findings are not borne out by the limited practical tests conducted by the author.

It is of interest to note that the standing-wave ratios estimated by the laboratory for various frequencies from 4 to 22 Mc. ranged from a minimum of 1.4 to a maximum of 2.6, with an average close to 1.7. These ratios compare favorably with average s.w.r.s found in amateur installations. It should be remembered that these standing-wave ratios were not measured but were arrived at by calculation.

Dimensions

Fig. 1 gives a general idea of the system with the important dimensions indicated except for the angle of tilt. Fig. 2 indicates the required tilt with a suggested pole arrangement and dimensions pertaining thereto. Two particular sizes should be of interest to amateurs, one of which will have maximum efficiency from 3.5 Mc. to 17.5 Mc. and the other being optimum from 7 Mc. to 35 Mc. Dimensions may be developed using the formulas set forth to cover higher-frequency bands, but at 28 Mc. and higher frequencies directional arrays are easy to construct and preferable because of the increased gain. The following dimensions are applicable to the frequency ranges indicated above.

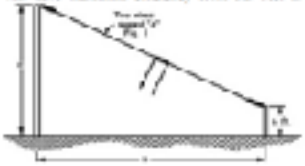

Fig. 2 — Tilting the terminated folded dipole tends to make the pattern nondirectional. For dimensions C and D see text.

Dimension (Figs. 1 and 2)	3.5 to 17.5 Mc.	7 to 35 Mc.
A	2 ft. 10 in.	1 ft. 6 in.
B	46 ft. 10in.	23 ft. 5 in.
C	36 ft. 0 in.	32 ft. 0 in.
D	90 ft. 0 in.	44 ft. 0 in.

For an impedance of 600 ohms, the center-to-center spacing of the feeder wires, divided by the diameter of the feeder wires, must equal 70. This means that No. 12 wire spaced six inches will be acceptable. Six inch spreaders are readily available and the wire will not stretch unduly. No. 10 wire should be spaced 7 inches and No. 15 wire should be spaced 3½ inches.

Terminating Resistor

The terminating resistor should be noninductive and have a minimum rating equal to 35 per cent of the input power to the final stage. It may be a carbon or graphite rod, adequately protected from the elements, or merely a long 600-ohm transmission line constructed of resistance wire. If the latter is used, the line may be carried vertically down from the center of one leg of the antenna to a short pole and then, if required, extended to one of the masts and doubled back and forth between the masts. If a carbon resistor is used, there is apparently no difference whether the rod is connected directly into the antenna as shown in Fig. 3, or at the end of a transmission line, as shown in Fig. 1. However, it is easier to adjust the resistance and protect it from the elements when it is installed at a fixed location on the ground than when it is suspended across an insulator in the antenna wire.

Formulas

The following formulas will be of assistance in developing antennas for different frequency coverages:

$$\text{Antenna-wire spacing (A) for lowest frequency} = \frac{3{,}000}{f(\text{Mc.})} \times 3.28$$

$$\text{Antenna length, each half (B) for lowest frequency} = \frac{50{,}000}{f(\text{kc.})} \times 3.28$$

To convert decimal parts of one foot into inches, multiply by 12.
One meter = 3.28 feet.

$$\text{Frequency (kc.)} = \frac{300{,}000}{\lambda\,(\text{meters})}$$

The length of the antenna and the wire spacing may well be the object of further experiments but initial tests indicate that the first two formulas shown above are reasonably accurate and that the system is operable over a 5-to-1 frequency range as previously mentioned.

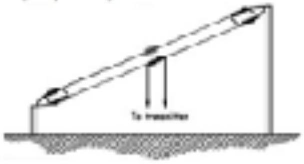

Fig. 3 — The terminating resistor may be placed directly in the antenna, or at the end of a transmission line as indicated in Fig. 1.

Initial tests with these antennas indicate no change in signal strength on 40 meters at a distance of 2000 miles when compared with a conventional half-wave antenna, center fed with tuned feeders and carefully adjusted for optimum output at one selected frequency. Good reports were received on both 20 and 80 meters but comparative reports are not available because of the lack of antennas specifically designed for these bands. Transmitter loading was normal.

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* Comdr., USN; Electronics Officer, Boston Naval Shipyard, Boston, Mass.

Performance of the Terminated Folded Dipole

November 1951

G. L. COUNTRYMAN, W3HH*

Every once in awhile an antenna comes along that could be put to good use by the average amateur. The Terminated Folded Dipole (also known as the T2FD) is just such an antenna. Unfortunately, it has not been given its due publicity. This article is designed to clarify some of the points on the construction, as well as report upon experimental results.—Editor.

INITIAL experiments with a terminated tilted folded dipole antenna were described by the author some two years ago.[1] This antenna has nondirectional characteristics and a 5 or 6 to 1 frequency ratio which means that one "untuned" antenna is all that is required for operation on from three to five amateur bands.

The antenna has a definite application in connection with emergency communications in the lower frequency bands.

1. One antenna is all that needs to be erected for operation on several bands.
2. Only one elevated point (pole, tree or house gable) is required.
3. Less space along the ground is needed for any given frequency as the canopy portion is shorter than the equal one-half wavelength.

Basically, the antenna is the hypotenuse of a right angle triangle, one leg of which is along the ground, as shown in *Fig. 1*. The spacing between the folded dipole wires, in feet is equal to 3,000 divided by the frequency in kilocycles, and the result multiplied by 3.28. The length of each leg in feet (from either end to the center insulator or resistor) is equal to 50,000 divided by the frequency in kilocycles, and the result multiplied by 3.28. The terminating resistor should have a wattage rating equal to 35% of the power input to the final stage, and should have a resistance equal to the impedance of the two wire feeder system—usually 600 ohms.

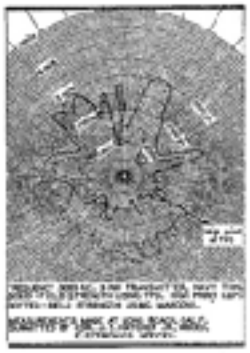
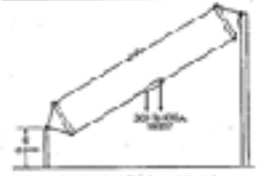


Figure 2



Erect so that the angle of tilt is about 30 to 40 degrees for nondirectional operation.

Figure 1

The formulas given are for the lowest frequency on which operation is desired. Applying these formulas an antenna that will work well on the 10, 11, 15, 20 and 40 meter bands may have an overall length of forty-seven feet, with the two wires spaced about 7 inches.

During the past few months the response has indicated that there is considerable interest in, and several applications [illegible] of the T2FD antenna. Some criticism from the theoretical [illegible] who dismiss the practicability with the statement "It won't work," has also been received.

As far as the author is concerned work on the antenna has progressed [illegible], due to the pressure of other duties, although additional tests continue to indicate that the formulas for length and spacing are accurate. Elsewhere, experimenters have reported advantages to be gained by [illegible] according to formula at the antenna ends, and doubling that spacing at the center. The author has found that this apparent advantage is realized only because a center spacer is needed that will keep the wires fixed in their relative positions. It definitely appears that a center spacer is a good idea but the dimension should keep the two antenna wires parallel throughout their entire length.

TABLE I

The only modification to the original data is that further experiments indicate the angle of tilt is not critical. Any tilt angle from about 20 degrees to about 40 degrees will radiate with nondirectional characteristics. This greatly increases the flexibility of the system.

Performance Review

Luis Carreras, W2EC, reports that one antenna has been used on the Model TCK transmitter at [illegible] for over a year on all frequencies with [illegible] on the various bands. The other antenna has since been removed. The Model TCK is a Navy 1 KW transmitter of modern design, with a frequency range from 2,000 to 18,000 kc.

Captain H. O. Crisp [illegible], now retired, reports highly satisfactory results and suggested a wide center spacing. He also reports excellent results on receiving [illegible] than could be accounted for by the antenna and transmission line presenting a better load match to the receiver than a comparative single wire and "earth". He used an RCA AR88D in the receiving tests.

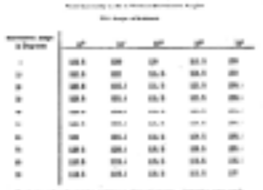


TABLE II

Commander F. E. Thomas, USN, W1AUJ has reported that four of these antennas were erected at the Naval Station, Long Beach, California. Each T2FD was connected to a separate transmitter. They were used over the entire frequency range of the antenna with excellent results. The antennas were erected along the sides of a square with the building housing the transmitters in the center of the square. Poles were erected at each corner and each antenna ran from the top of one pole to a point near the bottom of the pole at the adjoining corner. *Figure 2* shows field strength measurements made at this station comparing the T2FD and the Marconi antenna formerly used.

Some of the most interesting observational material was from Mr. [illegible]. Mr. [illegible] is a Radio Engineer for the Kyushu [illegible] Communication Bureau (Japan). After extensive tests Mr. [illegible] has recommended that the T2FD antenna be used for all coastal, emergency and domestic radio transmitting stations on Kyushu Island. His permission has been received to publish the results of some of their field strength checks and propagation tests.

Briefly their experiments indicated that the tilted folded dipole was superior to the "Zepp" and other [illegible] types previously employed. Wide band characteristics were observed and the T2FD resulted in a 6 to 8 db increase in the signal at their various receiving locations. Tables I and II are self explanatory and should be of interest to antenna minded experimenters. Table I shows that reception from the tilted folded dipole gave an equal or louder signal at three widely separated locations, as compared to conventional dipoles. Table II shows the actual field intensity in db at five different tilt angles over a 90 degree horizontal pattern. The field strength from the same transmitter using a horizontal "Zepp" antenna was 111.5 db at all points. The distance from the field strength meter to the antenna was about two miles.

The author has had excellent practical results with the antenna. One big advantage to many hams who are not fortunate enough to live in an area permitting an "antenna farm" is that only one elevated point is required. Only 30 feet along the ground is required for operation on 75 and 80 meters, and only about 15 feet is required for a 40 meter T2FD. The 80 meter antenna will function equally well on 40 and 20, while the 40 meter job will give excellent results down to and including the ten meter band.

---

*Capt., USN, 100 Windsor St., Silver Spring, Md.

a

Ken Crawley, WB4ENE on the T3FD

This antenna construction aid is for a relatively new, quite misunderstood, and often maligned antenna design invented in the 1940s. Described as the "Robinson-Barnes dipole", the "multi-wire dipole", and the "**T**erminated **3**-wire **F**olded **D**ipole or Travelling Wave Antennae."

Salient findings vs folklore,

1. Transmit power losses are overblown.
2. The T3FD truly lowers the Rx noise floor.
3. The T3FD is a magnetic loop antenna!
    a. Being magnetic, (current is not zero & voltage is not always maximum at the end insulators)
    b. interaction with nearby objects is irrelevant, unlike as we are told to avoid with our OCFD, Windom, EFHW, G5RV, and other voltage dipole constructs.
    c. The T3FD does not couple with objects and create bad common mode noise problems in the shack.
4. The T3FD is inherently more survivable in the event of a Coronal Mass Ejection (CME). Installation suggestions also make upgrading near to or direct lightning strikes and NEMP resistance possible.
5. The T3FD will function while touching the ground if the wire has insulation. With 2 or 3 pulleys, nighttime NVIS configurations are possible, and the SWR does not go nuts.
6. The T3FD VSWR curve can be "windage adjusted" by selecting other BALUN impedances. BALUN installation near ground, using Window or better, open-wire, to the feed cage, swaps and measurement are easy. Heavy coax stays out of the air.
7. Hundreds of model parametric design sweeps show the load resistor is best in the 1000 Ω, non-inductive range. Commercial designs will often have more R so users won't be turned off by poor VSWR Curves. It is always a good idea to optimize R when building each new custom length antenna.
8. If two stations switch to using this antenna type, their combined noise floor reductions profoundly improve communications circuit reliability. It is like buying each other a linear amplifier!

Ken Crawley, WB4ENE 2018 kencrawley@hughes.net

The construction tips and information can be used for any length of antenna. It is highly recommended to make your antenna as long (from insulator-to-insulator) as you can. The longer, the better. Your receiver and transmitter will thank you for it. You will find the SWR will be low (typically less than 2:1) over the entire band from 160 to 10 meters. Test results are included for a 88-foot 8 inch Terminated 3-Wire Folded Dipole (T3FD) below in this document.

Construction Notes T3FD

Preparation of the two end spreaders for each side of the dipole – a total of four. Each spreader will have 6 holes drilled allow the 1/8-inch stainless steel (SS) cable pass through three of the holes in all spreaders, one inch from each end of the spreader and the center. A perpendicular hole is drill next to each of the three holes for all spreaders to allow for the 16-gauge aluminum wire to wrap around the SS cable to secure it in place. I used a drill press to make the holes for the each of the holes in the spreaders.

On a side note, the 1/8-inch SS can be secured without passing through the spreader. Instead, have the cable lay on top of the spreader and use the 16-gauge aluminum wire to pass through one of the holes and wrap around the 1/8-inch SS cable. This way if you're spreader breaks (highly unlikely), you will NOT have to rethread the 1/8-inch SS cable through the spreader.

If your spreader pole is like mine – fiberglass, be sure to use a Shop-Vac to evacuate the fiberglass dust. See the photos below.

The dimensions for this Terminated 3-Wire Folded Dipole (T3FD) is 88 feet 8 inches insulator-to-insulator. Therefore, all the dimension you will see in this document are cut for this antenna. If you can make your T3FD longer, by all means please do so. The longer, the better. However, your space will dictate your antenna length.

Total wire used: 288.3 ft

Two center wires - cut to 43.5 ft
Four outer wires cut to 50 ft 4" – OR – Two 100 ft 8" continuous wire for each side. I used the latter.

<u>Constructing the T3FD - 88' 8" antenna</u>

1. Start with one side of the dipole first. The other side will be exactly the same.
2. Attach an end insulator with guy rope to an object (ie: tree) so you can stretch the wires out fully to measure.
3. One continuous wire for the outside wire and one center wire will be run through the end insulator. Three binocular core clamps will physically secure the outer and center wire at the end insulator. As you can see, the center wire is crimped in three places. See photo to the right.

4. Use a crimper similar to this one below to make all of your crimps.

5. Once you have the end of the 3-wire attached to the end insulator, take two of the prepared spreaders and thread the stainless steel (SS) wire through each of the three holes as shown below. NOTE: The picture below shows the two center spreaders, right and left side of the dipole. You will have the two spreaders for each side of the dipole. One of the spreaders is not shown and is near the end insulator. The other one is in the center as shown below. You will join both ends of the dipole together later using 10 – 12-inch section of PVC. The terminating resistor, shown in the middle – upside down – will also be added later.

6. The SS cable will be secured with the 16-gauge aluminum wire as shown below.

7. Repeat the previous steps for the other end of the dipole antenna.
8. Be sure to have at least 46" of outer wires dangling under each of the two center spreaders. You will attach these four SS cables to the 450 Ω Window line in a step later.
9. Take the two-center wires and thread it thru the center insulator, leave 6" hanging down.

Terminating Resistor

10. The two center wires will be attached to the PVC and the 1000 Ω termination array. Use 16-gauge wire to secure the SS cable into and out of the PVC as shown in the photos below.
11. These SS cable will be terminated with a terminal lug to attach the resistor array. I used a bolt, lock washer and nut thru the lug hole of each resistor. Also note, there is a short section of metal strap h set of

12. After the SS cables have been attached to the termination resistor array, I applied liquid tape to seal all connections to prevent moisture corrosion.

13. Use the 16-gauge wire to wire wrap the SS cable securely to the fiberglass spreader in three places on each of the center spreader as previously shown in the previous page.
14. The remaining outside wire, threads through the fiberglass spreader; leaving 46" dangling and secure these wires to the fiberglass spreader as well as the PVC using the 16-guage aluminum wire.

15. The finished results should look like the photo below. Note: The photo below shows it is side down for ease of making the connections. When it is ready to hang, the antenna will be flipped over so that the resistor array will be hanging below the center PVC tube.

Midpoint Spreaders

I also used two small diameter spreaders (1/4 inch) to secure the three wires to be equal distance from each other. I drill three small holes into each spreader, large enough to pass the 16-guage aluminum wire through the spreader to secure the 1/8 SS cable to each spreader. The midpoint spreaders are secured underneath the 1/8 SS cables as shown. I used one midpoint spreader on each side of the dipole which was equal distance from the end insulator to the center of the T3FD. See the photo below.

Installing the 400 Ω Window (Ladder) Line

In my installation, I used the WA1FFL Window-LOC purchase at HRO. However, I'm sure there are other sources for this mounting bracket. The Window-LOC is purely optional. You can connect the 1/8-inch SS cable by simply using bolts, lock washer, washers and nuts to make the necessary connections.

It is important connect the 1/8-inch SS cable correctly. The two cables coming from one side of the dipole are connected to one side of the Window line. The other two cables from the other side of the dipole are connected to the other side of the Window line. See the attached photos for clarification.

Once the Window line is attached to the 1/8-inch SS cable, the Window line hangs down to attach to your BALUN. In my case, I used a 9:1 BALUN attached to the outside wall of my QTH. The 50 Ω coaxial cable is then attached to the BALUN and brought into my Shack.

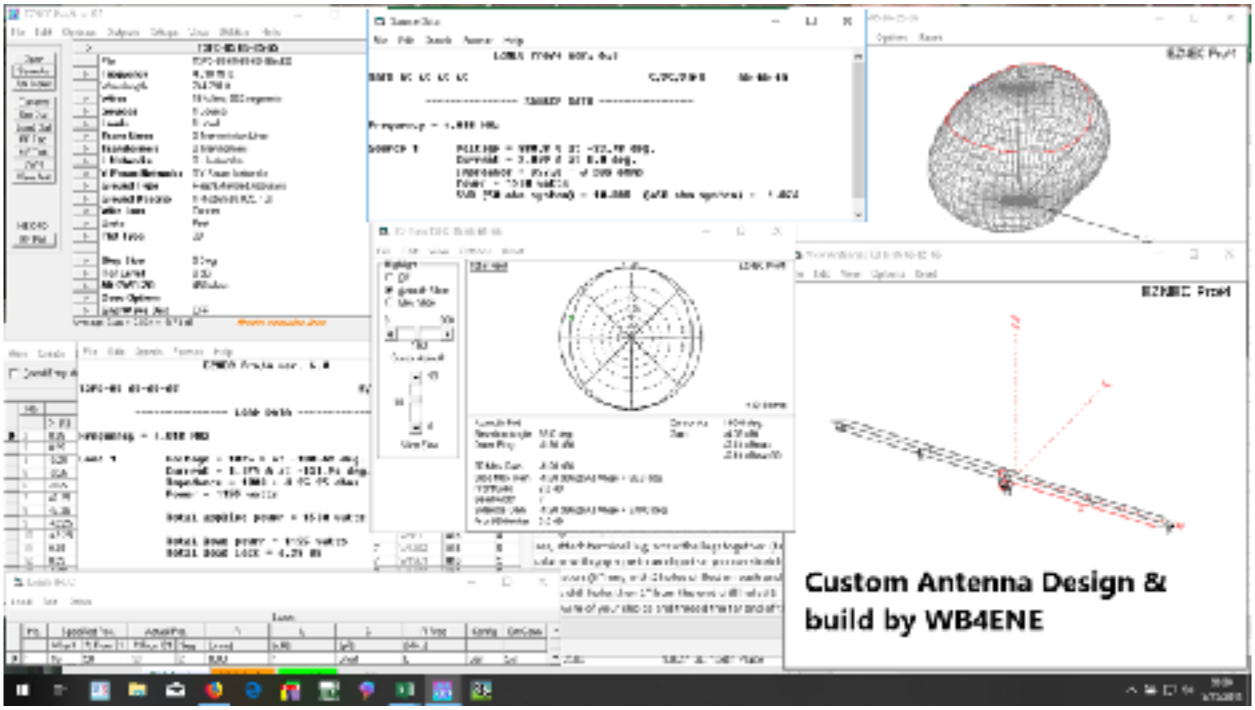
The ‘Cage’

1. The overhead support above the ‘cage’ shown below is an option method to hang the T3FD antenna. This method is recommended for long antennas greater than 150 feet end-to-end. For antennas less than 100 feet, the overhead support system is not necessary. Merely hang the antenna from each end insulator will work fine.
2. The ‘cage’ is the part of the antenna that connects the center of the T3FD antenna that has the 3-wire on each end and the terminating resistor connecting the center wire.
3. Each end of the outer wires will drop down about 46 inches where the connection to the 450 Ω Window line will be attached. As you can see in the photo below, this T3FD is not using the WA1FFL Window-LOC or similar mounting device. The outer wires are attached directly to the Window Line.
4. Each side of the outer wire will be connected to one side of the Window line as depicted in figure below.

Figure 1

5. The Window line will then drop down to ground level where it will be attached to a 9:1 BALUN. I used the BAL-450 by CWS Bytemark. www.cwsbytemark.com
6. The coax will then be taken into the shack.


CWS ByteMark
W2FMI
BALUN TRANSFORMER
Model No.



Custom Antenna Design & build by WB4ENE

In this document we will refer to it as the T3FD, with added numeric descriptors which describe the lengths of the wires and the erected elevation profile. The T3FD is extremely flexible in terms of how it is cut and erected. Construction & materials spanning from MIL-SPEC to surplus field-expedient quality almost always providing a "no-tune" VSWR curve on <u>any assigned frequency</u> in the HF spectrum! It has operated as a Net Control Station Antenna while half on the ground and snagged in trees thanks to storms and cheap component failures. In other words, it degrades gracefully.

A typical T3FD antenna is <u>fully depicted</u> as: T3FD-89 (4) 60-25-60 E-W

John's constructed his first T3FD with the distance between end insulators as 89 feet (well, it is actually 88'8"), 4 feet of outer wire spread, and the elevations of 60' on one end (the E in this case), 25' at the center feed, and 60' on the other end (W).

With that nomenclature he provided to me, I constructed a rather accurate NEC model to provide him with very important radiation angles in 3-dimensions at HIS ACTUAL HEIGHT. We all know how high & where we put our antennas is often dictated by trees, neighbours, spouse, HOAs, and the property size!

The only factors unknown in my model constructs are the "ground conductivity" and other major conductive objects. With those values I have found the calculated VSWR curves to mimic the shape as measured in the real world when accurate analyser techniques are employed.

I have over 2000 hours constructing NEC models of over 200 lengths, other off the wall wire configurations (like 5-wire with the centre in the middle of the X), and the very important personal height profiles! Being retired has its benefits.

I began studying this antenna in 2016, just prior to re-joining Army MARS in 2017. I erected a Bushcomm 90ft "multi-wire" antenna. After I deliberately overloaded it with power, I found that users of this antenna would benefit knowing the secrets behind its construction, how it can actually be tweaked with BALUN Z choices, as well as HOW TO REPAIR it, and how to run as much power as possible with it.

Tools Required

Phillips screw driver	
Sockets and wrench	
Crescent wrench	
Pliers	
Wire Cutter for 3 mm steel cable	
Crimper for binocular clamps and spade lugs	
Tape measure	25 foot & 100 foot
Shopvac	
Gloves	Latex and leather
Drill or drill press with drill bits	
550 cord	
Ground stakes	

Billing of Materials (BOM) for a T3FD – 66-88-66

Item	Cost	Source	Qty needed	Total Cost
6GSS7X7 SS Cable 500 feet T316 Stainless Steel Cable 1/8 Inch 7x7 Steel Wire Rope Cable 500ft Cable Railing for Railing Decking DIY Balustrade (500ft)	$98.99	Sanyan Corp	~280 feet	$98.99
2 End Insulators	$2.00	Hamfest	2	$2.00
Fibermarker Driveway Markers 1/4-Inchx48-Inch White 6-Pack Solid Fiberglass SnowMarkers Highway Markers Spreaders (6)	$17.50	Amazon	2	$5.83
9:1 BALUN BAL-450	$75.95	CWS Bytemark	1	$75.95
Window Line 450 Ω - 100 feet	$39.95	HRO	1	$39.95
WA1FFL Window-LOC	$15.95	HRO	1	$15.95
3/32 in Ferrule & Stop Set clamps	~ $1.24	Home Depot	6	$7.44
Terminal Lugs		Home Depot or junk box	6	
3/16 X 500 Ft Dacron Black Polyester Black Cord	$47.95	Amazon		$47.95
1/16 inch Wire Rope Aluminum Sleeves (100)	$7.99	Amazon		$7.99

Item	Cost	Source	Qty needed	Total Cost
1000 Ω non-inductive terminating resistor 8 – 500 Ω non-inductive resistors wired in series/ parallel = 1000 Ω				
Coax – 50 Ω				
Delrin Rod 4 x 4 x $2.96	$2.96 / foot	ePlastics.com		$47.36
4 foot plastic pipe	$4.95	Lowe's or Home Depot		$19.80
4 – 4 foot Fiberglass Stake used as spreaders	$5.97	Walmart Wilco	4	$23.88
Aluminum fencing wire – 17ga 250 feet	$11.24	Wilco	Approx. 25 ft	$1.25
Liquid Tape	$7.19	McLendon		