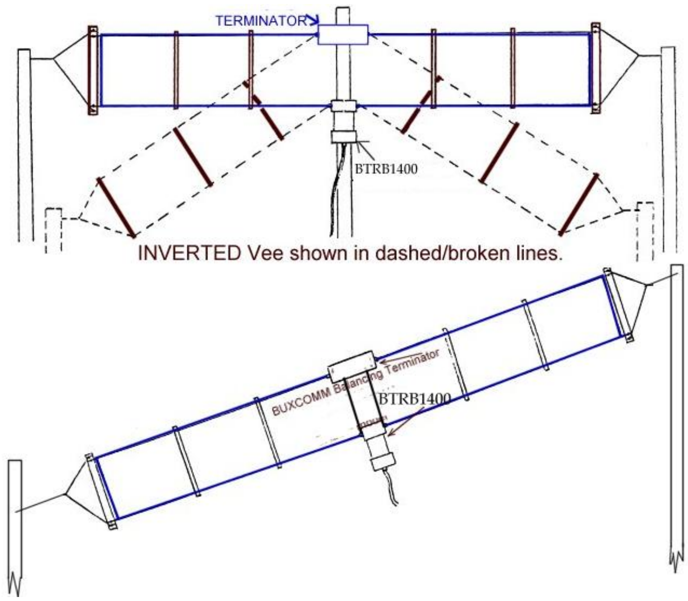
Building the Balanced Termination Folded Dipole, (BUXCOMM 1606FD)

By Glynn E "Buck" Rogers K4ABT



The T2FD, modified to a *Balanced Termination Folded Dipole* (BTFD)

Over the years I have built many antennas, Windom's, Dipoles, Folded Dipoles, balanced terminated folded dipoles, BTFD or T2FD broadband antennas. I prefer to call the latter a "balanced, termination folded dipole (BTFD)." When tilted to a 30 degree incline, it is called a T2FD, or Tilted-Terminated-Folded-Dipole. It can be designed for any number of frequencies between 1.8 and 30 mHz. The original balanced termination, folded dipole (T2FD) was the design of amateur radio operator (*An Experimental All-Band Non-directional Transmitting Antenna" by Gil L. Countryman, W1RBK, (W3HH), QST, June 1949)*, the antenna was first used for maritime and naval communications.

It was 1958 when I built a modified version of the T2FD. Instead of using the 600 ohm, non-inductive termination, I used an 450 ohm termination, and added the Guanella version of a transmission line transformer (TLT) 9:1 BALUN. Our balanced termination, folded dipole (BTFD) now provided an excellent bandwidth using the balanced termination, folded dipole (BTFD) designed for a low frequency with the upper frequency limit extending well above 50 megahertz. In the articles I had read that when the Tilted-Terminated-Folded-Dipole (T2FD) is installed with the 30 degree incline, that it would exhibit an omni signal pattern.

In 1966, while doing some experimenting with the balanced, termination folded dipole, I installed it with the 35 degree incline. After several contacts, I soon discovered there was a lack of back-fill in the direction behind the incline. To circumvent or at least correct some of the back-fill problem, I raised the high end (tall pole) to 35 feet, and brought the low end to slightly over 6 feet. After all the raising and lowering of the ends, the antenna's signal still favored the slope side or direction of the low end. In subsequent tests I found that either horizontal, or sloped, the antenna exhibited similar coverage. If anything, the flat-top or horizontal installation may have displayed an edge over the sloped installation.

ROLL YOUR OWN T2FD or BTFD:

To determine the dimensions of a BTFD or T2FD using 450 ohm termination and 9:1 BALUN use the following formulae to calculate the dimensions. My reason for developing the formulas using PI or 2 times pi (6.28) is to make the calculations linear when computing dimensions for bands other than the bands used in the examples below. Example; 3.8 Mhz to 30 Mhz, 7.2 to 30 Mhz..etc.

> In addition to the formula for the 450 ohm T2FD and 9:1 BALUN shown here, here is a formula for the 450 ohm balanced termination, folded dipole that uses a 9:1 BALUN with a similar (BTFD) overall length: 166 divided by the frequency in megahertz = antenna length (Ft); thus **166/1.85 Mhz** = 89.73 feet. For meters, divide feet by 3.28, or 89.73 ft divided by 3.28 (**89.73/3.28**) = 27.36 meters. **16 inches**. *Wire/element spacing is not a critical dimension, and can vary +/- 2 inches MOL.*

Thus you now have the dimensions you need to build a T2FD balanced termination folded dipole (BTFD).
An ***important NOTE to remember:*** These calculations are based on the T2FD using an 450 ohm non-inductive BTR, and the BUXCOMM B15KC91 BALUN, or the **1606T2FD**

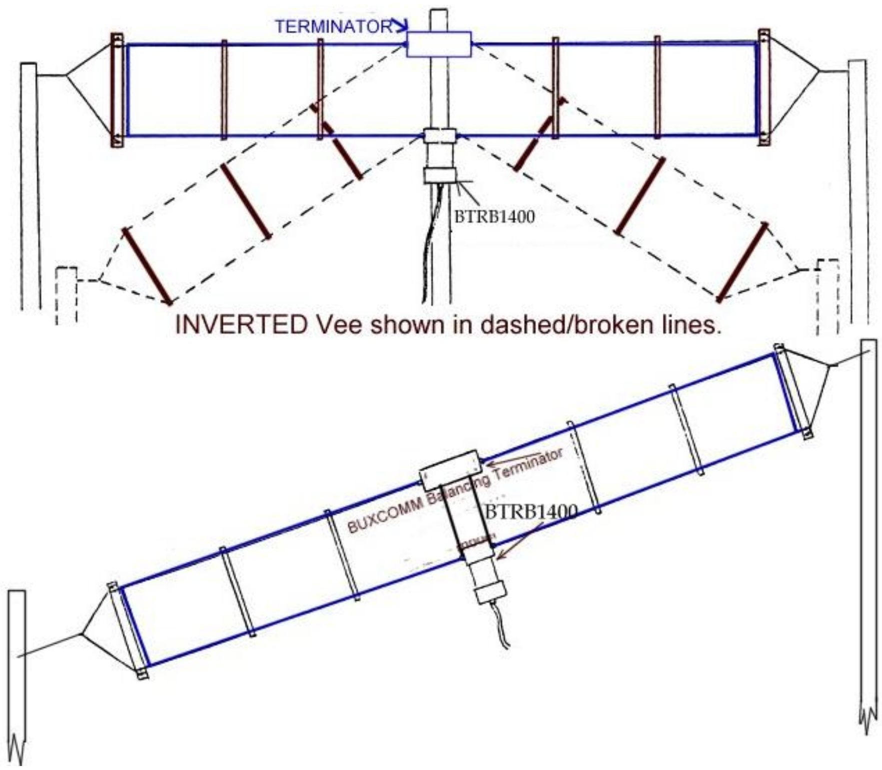


Figure 1: Several installation configurations for the The balanced termination, folded dipole (BTFD) BUXCOMM model 1606FD

The balanced termination, folded dipole (BTFD) is an extremely broadband antenna, and it is a very quiet antenna indeed, as it is immune to terrestrial noise as compared with a vertical or a horizontal dipole. The SWR, Standing Wave Ratio, when transmitting may vary from an almost perfect match of 1.1:1 at some frequencies to 2.5:1 at other frequencies. In either case, either reading is good when you consider you are able to operate across the HF spectrum without an antenna tuner.

Balanced Termination, Folded Dipole (BTFD) BUXCOMM model 1606FD, Low-Noise, High-Performance, Antenna Features:

* Frequency range 1.8 - 55 MHz
* Can be used as an SWL monitor or transmit antenna from 1.8 - 30 MHz
* Low-noise design, reduces sensitivity to terrestrial man-made noise and atmospheric static.
* Constant sensitivity over the entire frequency range without an antenna tuner.
* Coaxial cable between antenna and receiver.
* Length, 27.5 meters
* Passive, therefore no inter-mod
* Antenna is complete, ready to erect.
* Heavy duty construction, both wire and fiberglass.

Advantages of the balanced termination, folded dipole (BTFD) antenna:
The balanced termination, folded dipole (BTFD) (Tilted Terminated Folded Dipole), originally developed by the US Navy, is an antenna still in common use by military and government receiving stations. There are good reasons for this choice by the professionals. The antenna has a balanced termination which provides it with its characteristic impedance. This terminated principle means the antenna is not prone to annoying man-made interference sources, such as fluorescent lights, dimmers, televisions etc. The antenna is also less subject to noise from likely causes, such as atmospheric static and open high-tension power lines.

The balanced termination, folded dipole (BTFD) is really a "low-noise" transmitting and receiving antenna! By ensuring a constant impedance throughout the length of the antenna, the balanced termination, folded dipole (BTFD) is also less prone to distortion due to multi-path fading. Our tests have shown that when compared to dipole or long-wire antennas, the background noise with a balanced termination, folded dipole (BTFD) antenna is not only much lower, but allows weak signals normally not heard, to be audible and therefore legible.

One of the most desirable features of the BTFD is when using digital modes, packet radio, PSK, SSTV, MT63, etc, makes for easy recovery of their signals. The immunity to terrestrial noise reduces the number of errors in data communications simply because of its low noise figure and lower distortion.

The balanced termination, folded dipole (BTFD) does not suffer from dead spots across its frequency range as we have found the specifications for the BTFD are the same for its entire frequency range. This is not only a useful feature for SWL shortwave listener who likes to listen to both the broadcast and other communications services of the shortwave spectrum. This is also ideal for the HAM who often and hastily changes frequency.

Height is not a pre-requisite:
The ends of a dipole, trap-dipole, and long wire antennas have a high impedance. This is a problem when the wire runs in the vicinity of conductors such as metal roofs, trees, and similar vegetation. The balanced termination, folded dipole (BTFD) has fewer of these problems because of its constant impedance at any point of the antenna. In addition, the conductivity of the ground under the BTFD antenna has little influence on its performance. The height of the lower end of the balanced termination, folded dipole (BTFD) does not have to be more than 10 to 15 feet above the surface. If you hang the balanced termination, folded dipole (BTFD) with an angle of 30 degrees, then the antenna pattern shows a number of lobes that it may cause you to feel the antenna is sensitive to signals from all directions, or omni-directional. This apparent "omni-directional" can be a bit misleading, however the circularity of the T2FD pattern does is over 300 degrees, but falls short of a full circle signal capture.

This back-fill null is the result two properties:

1) Lack of back-fill aft the support mast,
2) Poor capture by the antenna in the E plane of the slope toward the low end.

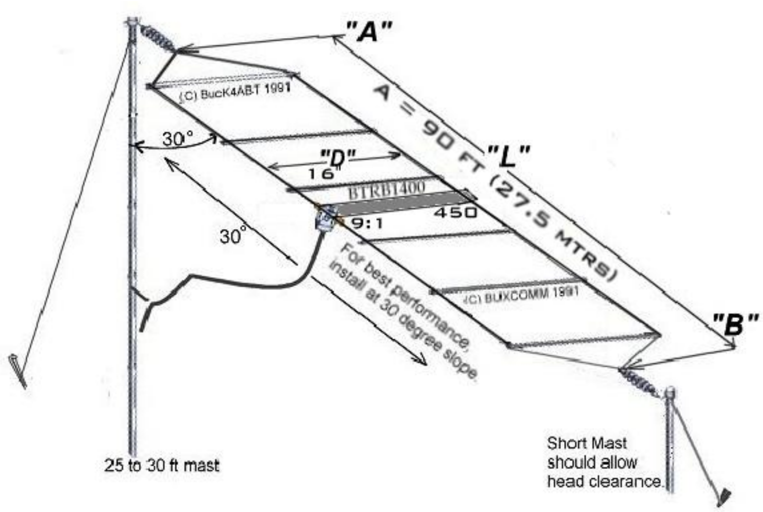


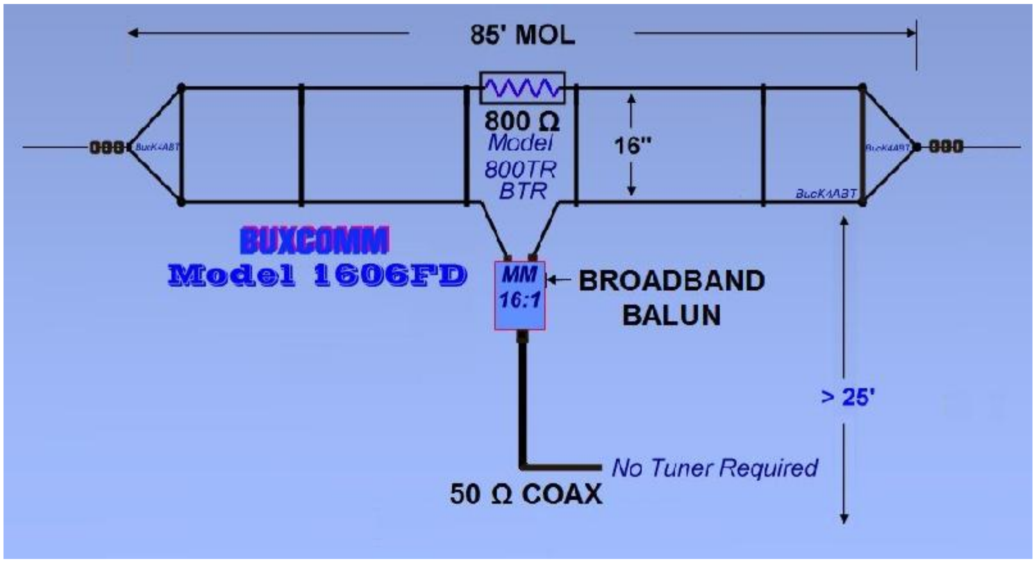
Figure ***2: Properly installed, balanced termination, folded dipole (BTFD) is omni-directional over most of its operating range.*** In addition to the formula for the 450 ohm T2FD and 9:1 BALUN shown here, here is a formula for the 450 ohm balanced termination, folded dipole that uses a 9:1 BALUN with a similar (BTFD) overall length: 166 divided by the frequency in megahertz = antenna length (Ft); thus **166/1.85 Mhz** = 89.73 feet. For meters, divide feet by 3.28, or 89.73 ft divided by 3.28 (**89.73/3.28**) = 27.36 meters.

We've calculated a "happy-medium" for spacing the top and bottom elements of the T2FD. To determine spacing between the wire elements of the T2FD, we use a constant of 30/Fmhz the formula is: **30/freq Mhz** = inches; thus **30/1.85 Mhz** = 16.2 inches. Since the spacing is not critical, we round it to 16 inches. The 16 inches, works as multiple fractions across the HF, HAM band spectrum, up to, and including 51 Mhz (6 mtrs).

Wire spacing is not a critical dimension, and can vary +/- 2 inches MOL.

A 30 to 35 degree angle enables the antenna to be sensitive for horizontally polarized, as well as vertical polarized signals. This feature is where the BTFD exhibits one of its inherent properties; *Reduced signal fading.*

Although the 1606TR is designed for transmitting and receiving, for reception the balanced termination, folded dipole is incomparable: For receiving purposes the balanced termination, folded dipole (BTFD) has an extra advantage. It is immune to man-made and low atmospheric (terrestrial) noise. On shortwave, this noise can be so high, that it decides the signal to noise ratio, in turn, the intelligibility of the received station.



When properly installed, the balanced termination, folded dipole (BTFD) is nearly omni-directional over most of its operating range.

The balanced termination, folded dipole (BTFD) Antenna:
BUXCOMM has experimented with the balanced termination, folded dipole (BTFD) for several years, and from time to time, we have improved on the original design. By analyzing the problems from different angles, and trying various materials, the good points of the original design could be improved upon. The move from a 600 ohm termination resistor and adding the 9:1 BALUN was the greatest improvement. The latest design means that common coaxial cable can be used as a lead-in to the transceiver, eliminating ingressed interference from equipment such as computers, power lines, and fluorescent lights.

Photo 1: We make the characteristic impedance of the BUXCOMM balanced termination, folded dipole 450 ohms by using the BUXCOMM model 800TR.

LEFT, ***Photo 2:*** Thanks to the development of our wide-band 9:1 BALUN, the antenna is matched to the 50 Ohm coaxial cable and the input impedance of most transceivers.

This BALUN not only ensures symmetry in the antenna across its frequency range, it also isolates the coaxial cable from the antenna, reducing interfering signals that might be picked up by the shield of the coaxial cable.

Static discharge protection:

In addition, the BUXCOMM 9:1 BALUN is a current type BALUN. This ensures that the antenna-wire on the balanced termination, folded dipole (BTFD) is grounded, so that any static buildup during thunderstorms, is discharged to earth. This not only protects the sensitive input circuitry of the transreceiver, it reduces the atmospheric noise which is generated as a result. The BUXCOMM balanced termination, folded dipole (BTFD) is designed to withstand harse weather conditions and has survived wind's with speeds over 150 mph.

Again, the higher impedances tend to balance the power in each leg more evenly. We old timers have always used 800 ohm non-inductive balancing terminating resistors (BTR) for Rhombics, and 600 ohms for the terminated folded dipoles. However since 1965 I have found that better bandwidth and VSWR is best when using 450 ohm termination resistors and a 9 to 1 BALUN. I have written several books and articles about these antennas. In my writings I have demonstrated and illustrated the advantages of using the different impedances. In tests we have found that higher feed-point impedances tend to lose bandwidth at the higher frequencies, e.g. 20 to 30 Mhz. While using a BTR below 500 ohms, we've discovered that better bandwidth occurs along with *less* TVI. After a lot of trial and error, design changes, bridge, and grid-dip meter testing, we found a happy medium! Therefore, my focus has been to make these antenna(s) as broad as possible, while maintaining a relative smooth VSWR from 1.5 to 55 Mhz. The "happy medium" is to use a 9:1 BALUN and a *Balanced Termination Resistor* (BTR) at, or near 450 ohms.

To support the low frequencies, a BTR of 450 ohms with a BUXCOMM B15K91, 9 TO 1 BALUN provides a good match over wide HF frequencies that range from 1.8 to 30 Mhz while still minimizing TVI, and maintaining the antenna's inherent immunity to terrestrial (man-made) noise. To optimize the T2FD for the best of all worlds, 1.8 to 55 Mhz, we recommend the use of a 9 to 1 BALUN with an 450 ohm termination resistor.

The balanced termination, folded dipole (BTFD), or Tilted Terminated Folded Dipole (T2FD), is related to another well known antenna... the rhombic, known for its extraordinary performance and reproducibility of its radiation patterns. A balanced termination, folded dipole (BTFD) is "terminated" like the rhombic, a NON-INDUCTIVE RESISTOR is placed at the end of antenna, something which provides a LOAD or TERMINATION to the RF propagating along the antenna. But, the big differences between the balanced termination, folded dipole (BTFD) and the rhombic, are that the first is much smaller, has little or no directivity and fits into a rather small real-estate space, while a rhombic antenna may be several football field sizes, and transmits a narrow horizontal radiation pattern. The balanced termination, folded dipole (BTFD) is a very practical broadband antenna.

Wire size and mechanical concerns:
Building a balanced termination, folded dipole (BTFD) for the 1.8 to 30 Mhz frequency range requires taking into account some mechanical design considerations. For example, you can't use a smaller wire size for the antenna, as its span is such, that number (AWG) 16, or AWG 14 can be used.

In the late 1950s, we used bamboo or cured cane poles to make our wire spacers. In 1963, some of us decided to try different spacing, different (non-inductive) resistances, and finally settling on the design with optimum performance. Using a 450 ohm *balanced termination resistor*, a 9 to 1 BALUN and 1.4 ft (15-1/2 inch) spacers, a happy medium was within our grasps. Today, upper and lower wires of the balanced termination, folded dipole (T2FD) are kept at a uniform distance, we achieve this with fiber-glass spacers or spreaders. This length will vary when using half-inch (or small diameter) PVC.

Over the years, when I've had available real-estate, the WINDOM is my favorite, however when antenna property space is limited, I've turned to the Balanced Termination Folded Dipole (BTFD), or T2FD. *The reason these two are my favorites, I don't need an antenna tuner to cover the HF spectrum, and only one antenna meets all my HF operating requirements.* This one HF antenna will enable you to forget that collection of rhombic's, log-periodic, wideband dipoles and similar antenna arrays! Building your own balanced termination, folded dipole (BTFD) will be like having a number of dipole antennas for many bands all in a single antenna and fed with only one cable.

Yes, in addition to the formula for the 450 ohm T2FD and 9:1 BALUN shown here, here is a formula for the 450 ohm balanced termination, folded dipole that uses a 9:1 BALUN with a similar (BTFD) overall length: 166 divided by the frequency in megahertz = antenna length (Ft); thus **166/1.85 Mhz** = 89.73 feet. For meters, divide feet by 3.28, or 89.73 ft divided by 3.28 (**89.73/3.28**) = 27.36 meters.

Rather than zig-zag'n all over the place, we have calculated a "happy-medium" for spacing the top and bottom elements of the T2FD. To determine spacing between the wire elements of the T2FD, we use a constant of 30/Fmhz the formula is: **30/freq Mhz** = inches; thus **30/1.85 Mhz** = 16.2 inches. Since the spacing is not critical, we round it to 16 inches. The 16 inches, works as multiple fractions across the HF, HAM band spectrum, up to, and including 51 Mhz (6 mtrs).

73 de BucK4ABT Visit: www.HAMqrp.com