10.3 T2FD Tilted Terminated Folded Dipole

Basic theory

The T2FD (Tilted Terminated Folded Dipole) is a general-purpose shortwave antenna developed in the late 1940s by the United States Navy [45]. It performs reasonably well over a broad frequency range, without marked dead spots in terms of frequency, direction, or angle of radiation above the horizon.

Although inferior in electrical terms [46] to antennas specifically designed for given frequency bands, or optimized for directionality, its all-around performance, relatively modest size, low cost, and the fact that it does not require any complex electronic matching to operate with a standard shortwave transmitter, have made it popular in professional shortwave communications.

Also, since the late 1980s, amateur radio operators and hobby shortwave listeners have rediscovered this antenna, especially for broadcast receiving and for amateur two-way modes such as Morse code and PSK31 where brute force performance is not as important as a steady signal. There have also been (disputed) claims that this antenna is comparatively insensitive to man-made radio interference, making it useful in urban environments, where a low noise floor is often more beneficial than high received signal strength. The T2FD is useful for hidden indoor systems, or where several optimized frequency-specific antennas cannot be accommodated. For example: an indoor antenna only 7 m long will allow operation on all amateur HF bands above 14 MHz on transmit, and down to 7 MHz on receive.

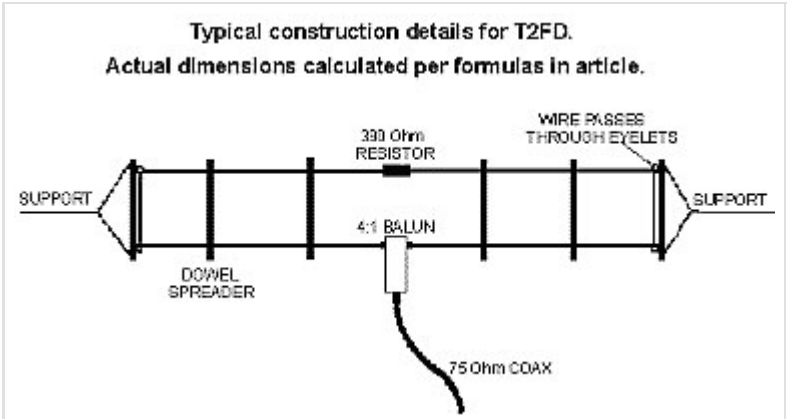

Fig. 10.3A.1 *Schematic of T2FD antenna*

Fig. 10.3A.2 *5 to 30 meter band antenna design*

A typical T2FD is built as follows, out of two parallel wire conductors:

- Span equals to 1/3 of the lowest required wavelength.
- Distance between upper and lower conductors equal to 1/100 of the wavelength. This distance is maintained by a number of insulating

dowels.

- Two dowels at the ends are tied to non-conducting ropes, in turn tied to supports.
- Upper and lower conductors are connected at the ends, by wire sections that follow the two end dowels.
- Fed in the middle of the lower conductor, with an impedance in the order of 300 Ω, balanced, through a standard 4:1 balun. This provides an acceptable all-frequency match to commonly available 75 Ω coaxial cable.
- Terminated in the middle of the upper conductor with a 400 Ω non-inductive resistor, rated to safely absorb at least 1/3 of the applied transmitter power. The resistor absorbs a growing portion of the RF power (either captured from the air or supplied by a transmitter) as the operating frequency nears the lower limit of the design range.
- In order to make it roughly omnidirectional, it is ideally strung sloping at an angle of 20 to 40 degrees from horizontal, but will also function satisfactorily if mounted horizontally, as long as it is pulled-out in a reasonably straight line.

Such an antenna is usable for both local and medium-long distance communication across a frequency range of about 1:6. For example, an antenna for the lower portion of shortwave (say, 3 to 18 MHz) will be roughly 33 m long, with conductors spaced 1 m. For the higher portion of shortwave (5 to 30 MHz), this antenna will be roughly 20 m long, with a spacing of 60 cm. If such long spans cannot be accommodated, smaller antennas will still give adequate receive-only performance down to about half of their lowest design frequency. Transmit performance, however, degrades rapidly below the lowest design frequency.

As a broadband antenna, the T2FD will normally display a reasonably low standing wave ratio across its entire frequency range. However; at some frequencies there may be a moderately reactive element within the loading, so the use of an antenna tuner may be beneficial when using modern, solid-state transmitters at anything approaching their rated power output.

Many ready-made commercial versions of the T2FD are available for the professional / military, amateur radio, and hobby listening markets.

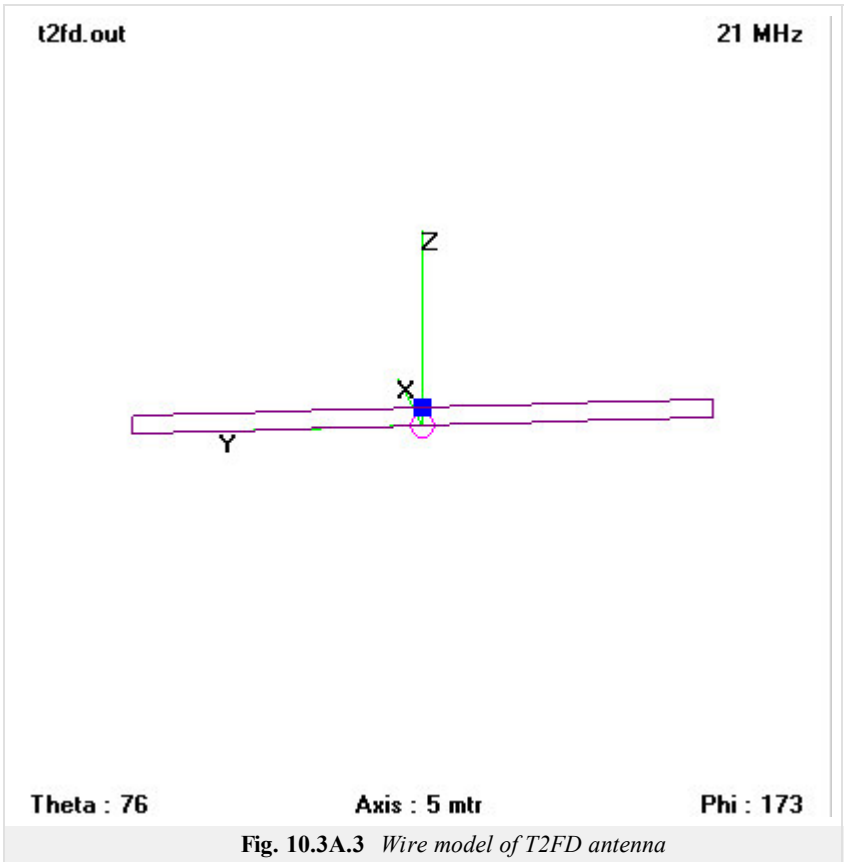

Fig. 10.3A.3 *Wire model of T2FD antenna*

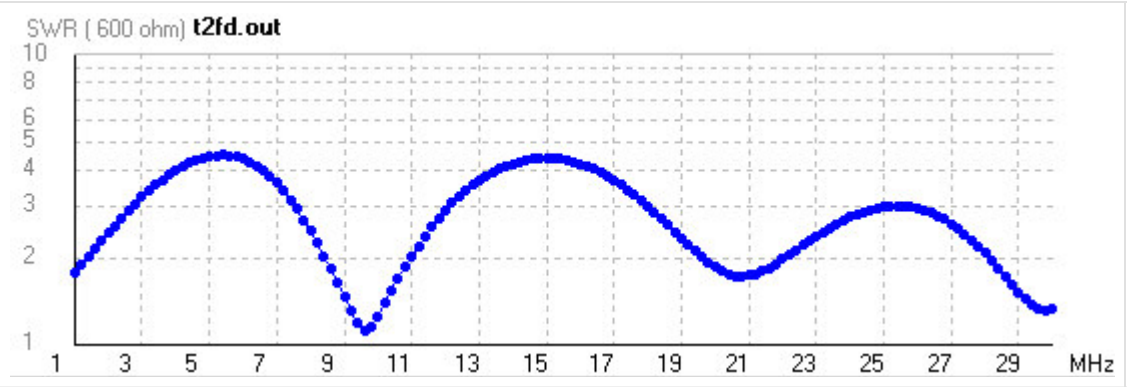

Fig. 10.3A.4 *Frequency response of standing wave ratio of T2FD antenna (the length l = 23.5 m)*

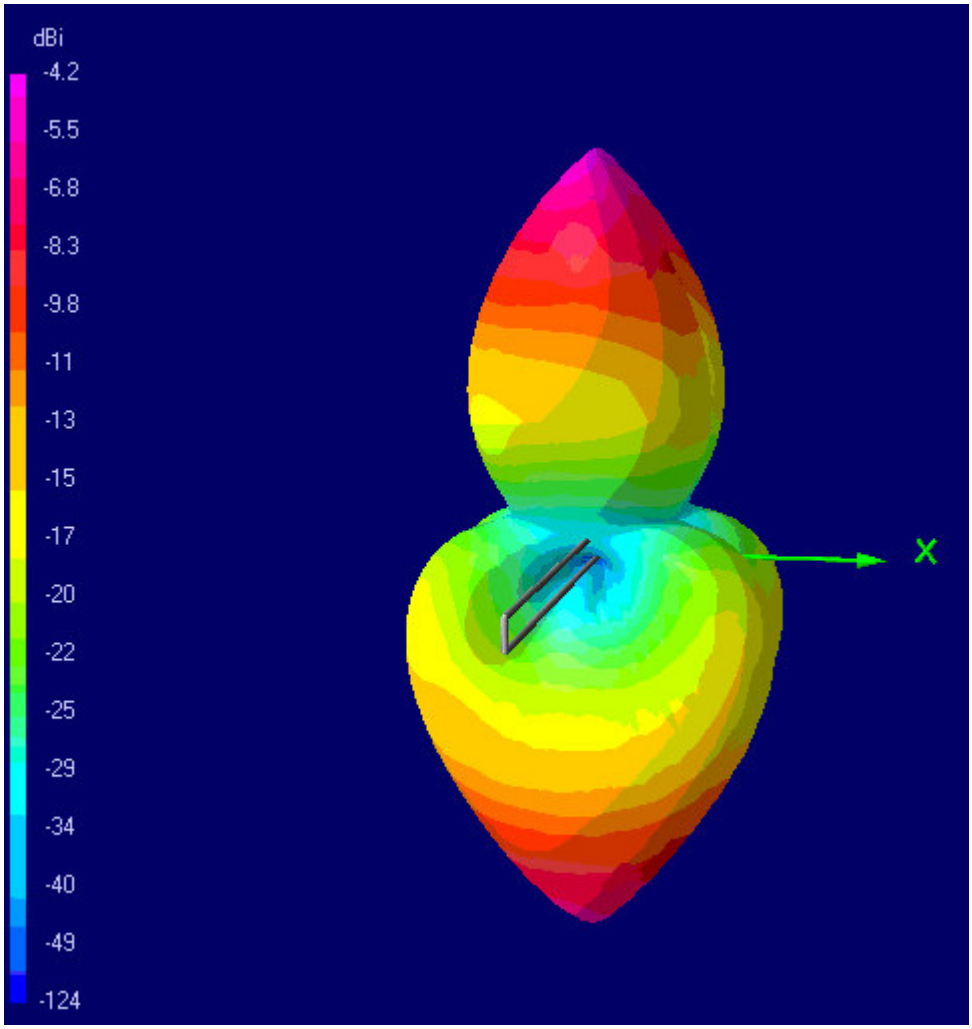

Fig. 10.3A.5 *Radiation pattern of T2FD antenna at 21 MHz (the length l = 23.5 m)*