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DOUBLE-FOLDED DIPOLE ANTENNAS

Rudolf J.F. Guertler
Antenna Engineering Aust. Pty. Ltd.
Melbourne, Australia

The double-folded dipole antenna[1,2,3] can be defined as a folded dipole of axial length L_1, loaded at its centre by a coplanar and geometrically parallel second folded dipole of axial length $L_2 > L_1$, Fig.1.

Counting the dipole elements from the feed point, elements no.1 and 2 have equal length, L_1, and are connected at the ends, thus forming a folded dipole with both elements open at the centre. The terminals of element no.2 are connected to the input terminals of a second folded dipole, consisting of elements no.3 and 4, of length L_2. The spacing between adjacent elements, i.e. between no.1 and 2, between 2 and 3, and between 3 and 4, may be the same fraction of a wavelength.

Two notably different versions of the double-folded dipole antenna have been tested:-

Type A, the wideband model: The second folded dipole is only a fraction longer than the first, driven dipole.

Type B, the multiband model: The second folded dipole is considerably longer than the driven dipole.

The wideband model, type A, can be used where all operating frequencies are within a single band, covering, e.g., several adjacent TV channels.

If λ denotes the wavelength at the mid-frequency of a range of maximum-to-minimum frequency ratio

$$f_{max}/f_{min} = 1.25,$$

the antenna may be designed so that the shorter dipole has a length of approximately

$$L_1 = 0.46\ \lambda,$$

and the longer dipole,

$$L_2 = 0.57\ \lambda.$$

The double-folded dipole is a back-fire antenna; it radiates from the back-elements towards the feed point. The E plane pattern has a major lobe with a maximum in direction S, Fig.1, and a minor lobe with a maximum in opposite direction.

The radiation pattern, the input impedance, and the gain of the antenna change only slightly over a wide frequency band, so that the antenna offers substantially the same performance at any frequency of the band.

The gain of the antenna can be increased and the back-lobe reduced by using the type A double-folded dipole as the driven element of a Yagi-Uda array: the reflector is placed behind the longer dipole, and the directors are in front of the shorter dipole. It is useful to taper the spacing of the first two or more directors, starting with the smallest spacing between L_1 and the first director. This array can be operatedalso over a wide frequency band, e.g. over several TV channels in the VHF range.

The double-folded dipole, type A, as a single unit as well as the driven element of a Yagi-Uda array, has been used as a TV receiving antenna in various areas of Australia where several TV transmitters are operating on rather close channels. For instance, a large country district is served by two stations, the transmitting antennas installed at a common site, one channel being 181 to 188 MHz, and the other being 195 to 202 MHz. The type A antenna used in this district comprises the folded dipoles, $L_1 = 0.73m$, and $L_2 = 0.91m$; spacing between adjacent elements 1-2, 2-3, and 3-4 is 5.8cm. The VSWR of this double-folded dipole was better than 2:1 in the range 175-210 MHz, and better than 2.5:1 over the range 170-215 MHz, with respect to 300 ohms. Measurements of radiation patterns at 179, 191, and 205 MHz, showed only small variations. At the mid-frequency, 191 MHz, the H plane beamwidth (between half-power points) is 134°, the E plane beamwidth is 46°, and the back radiation -12 dB with respect to the maximum field strength, which is quite remarkable for an antenna of compressed dimensions.

Type B antennas are designed for operation in two quite different frequency bands. For instance, the combination of band 63-70 MHz, and 181-215 MHz can be served by a double-folded dipole of approximately $L_1 = 0.72m$ and $L_2 = 2.10m$. This antenna behaves almost like a single dipole in the lower frequency band. In the higher frequency band, it exhibits noticeable gain and directive radiation patterns similar to the type A performance.

Type B double-folded dipoles have been used as TV receiving antennas in areas served, e.g., by a lower VHF channel, and two or three higher VHF channels, and in districts served by two lower VHF channels and two higher VHF channels. If more gain, or if radiation patterns with a narrower main lobe were required suitable reflectors and directors were added.

Considerably higher directivities can be achieved by employing two type A or two type B antennas in end-fire arrays. Also broadside arrays proved very satisfactory.

The double-folded antenna can be designed for unbalanced operation as a monopole erected above a conducting surface.

References:

1 Australian Patent No.250,311, "Antennas for Higher Frequencies", Inventor Dr. Rudolf Guertler. 7th October, 1959.

2 United States Patent No.3,167,775, "Multi-band Antenna Formed of Closely Spaced Folded Dipoles of Increasing Length"

3 British Patent No.927,051, "Improvements in or relating to Antennas for High Frequencies"

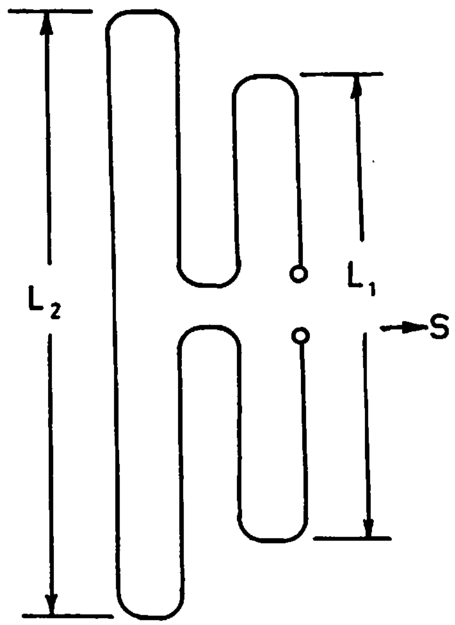

FIG. 1