80-meters Short Base-loaded Verticals

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This page is a collection of short vertical antennas that I built over the years, for the 80 mtr band. With "short" I mean between 3 and 10% of λ. That is a *lot* shorter than a standard 1/4 λ vertical. Anything less than 75% of full-size is actually a real compromise.

I am not interested in local QSOs, so I'd like my antenna to have a radiation pattern with a relatively small takeoff angle. Radiation straight up is to be minimized. The antenna has to be installed on my terrace, and I do not have the room for a network of radials - certainly not radials with a length of 1/4 λ on 80 mtrs. A tall order indeed!

The radiating element of a vertical monopole antenna is basically half of a dipole. The missing leg of the dipole has to be replaced by something else, for the monopole to "push against". This typically takes the form of one or more radials.

Let's take a monopole radiator that is short with respect to the desire operating frequency. To make it resonant at that frequency, some form of loading is required.

By the way: resonant operation is not a requirement - it just makes coupling to a feedline easier.

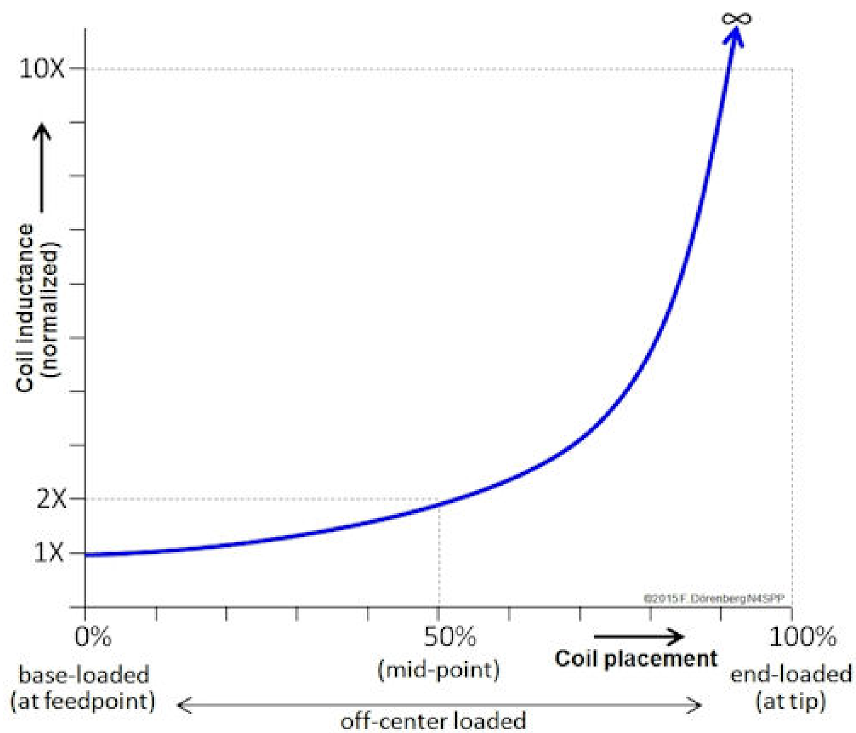
One standard solution is "inductive loading": placing a loading coil somewhere between the feedpoint at the bottom of the monopole and the tip of that monopole. The current-distribution along the radiator is such that the current is highest at the feedpoint. Placing a loading coil here, requires the smallest inductance. The current-distribution tapers off, from maximum at the feedpoint to zero at the tip of the radiator element.

As the loading coil is placed farther away from the feedpoint, a larger inductance is required. At the tip of the radiator, the current is zero. This would require an infinitely large inductance. See the diagram below. The placement of the coils ***does*** affect the shape of the current distribution, but does not change the fact that it is maximum at the feedpoint and zero at the tip.

Base-loading (i.e., at the base/bottom of the vertical radiator) is often easier to construct than *off-base* loading. A coil placed at the based of the antenna may be more easily accessible.

Why not always use base-loading? This is primarily driven by coil losses, hence, efficiency of the antenna. The coil losses basically depend on the current, coil dimensions, material, construction, and core.

Depending on the diameter of the radiator element (tubing, wire) and installation height, the most efficient placement of the loading coil is somewhere between 30 and 60% away from the feedpoint., around the mid-point.



Required loading-coil inductance as function of coil placement

Note that the efficiency-vs-placement curves are fairly flat over a relatively large range around the mid-point. This tends to shift towards the tip of the monopole when "capacitive hat" loading is added.

Some things to keep in mind when trying to build a good shortened vertical:

- Install the antenna (incl. radials!) as high as possible above ground (ideally > 0.05 λ), preferably over "good" HF ground. Damp garden soil is "good", swamp is better, salt water sea or ocean "best". Rock, (reinforced) concrete and hard surface in general is "bad".

- A reduced-size vertical antenna (radiator + radials) is easier to install higher up.

- A single, or a few (3-3) radials elevated at least 1-2 meters (3-6 ft) above "good" or "moderate" ground can be sufficient. Elevating the radials reduces the near-field absorption losses to ground - 0.03 λ is an absolute minimum installation height, especially if fewer than eight radials are used. When only a few (elevated) radials are used, the heavier the radial wires are, the better.

- With a single radial, the radiation becomes somewhat directional, favoring the direction of the radial. In general, all asymmetrical radial configurations cause directivity of the radiation pattern and more high-angle radiation. I.e., the takeoff angle increases.
  - Some examples of asymmetrical configurations are:
  - single radial
  - multiple radials, irregularly distributed around the vertical
  - multiple unequal length radials
  - multiple same-length radials with unequal coupling to the environment (e.g., unequal near-field ground losses)

- Especially with an elevated radial system, suppress common mode currents on the feedline with a current choke.

- Performance-wise, the most effective form of loading is "capacitive" end-hat loading, due to the way it changes the shape of the current distribution along the radiator. It adds hardly any loss resistance, whereas losses in loading coils, especially placed at the base where the current is highest are often quite significant.

- Increasing the diameter of the radiator from a thin wire to 10-12 mm (1/2") does more for improving performance than increases beyond that.

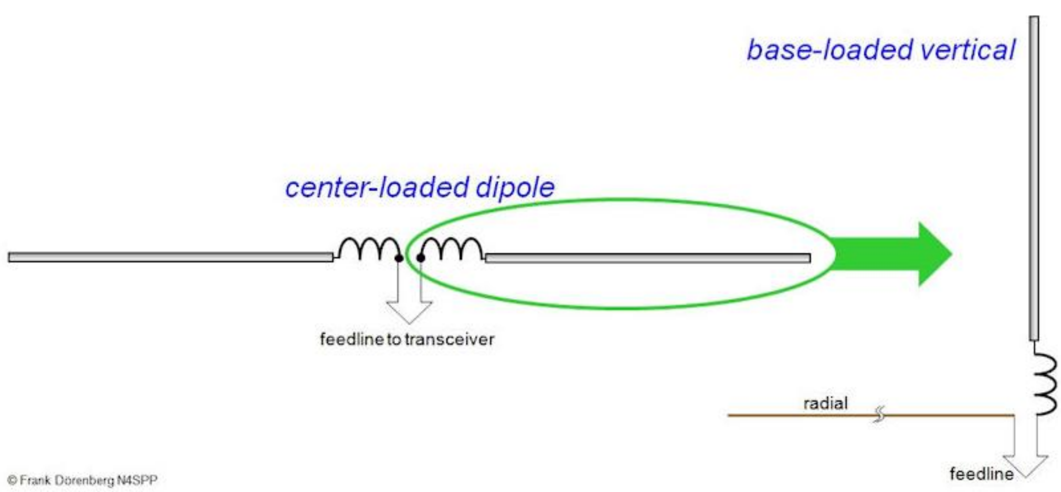
- Short, loaded antennas typically have a (much) smaller bandwidth than a similar full-size antenna. The higher the "Q" of the loading coils, the narrower the bandwidth. But when "Q" is lowered, antenna gain is ***decreased***.

- Any wire, however short and crooked, can be made to radiate.

Despite the above recommendations, the short verticals on this page are all base-loaded, and with just one or three short radials. Primarily for construction reasons, and because I converted some of them from center-loaded dipole experiments.

Short dipoles for the lower bands (40 meters and below) do not perform well for DX when installed horizontally at low height: significant ground losses, and a high radiation takeoff angle.

Take half a loaded dipole, add a single elevated radial and you have a loaded L-antenna or a shortened "Up & Outer" antenna. The latter is a 1/4 λ vertical with a single horizontal radial that is 25% shorter than the vertical radiator. The antenna is typically installed close to the ground (60 cm -1 m, 2-3 ft).



Discussions about loading of dipole antennas equally apply to vertical monopole antennas.

Source: https://www.nonstopsystems.com/radio/frank_radio_antenna_80m_vertical.htm