Ten-Tec Model 3402 and 3403 Broadband Antennas
Installation and Operation Manual
PN 74393

1. Introduction

The Ten-Tec Model 3402 Broadband Terminated Vee Beam Antenna offers continuous coverage between 1.8 and 30 MHz with a maximum VSWR of 2:1—typically 1.4:1 or less. The Model 3403 is a shorter version of the antenna that covers 3.5 to 30 MHz with a maximum VSWR of 2:1—typically 1.4:1 or less. For both models, VHF coverage is also provided for with a maximum VSWR of 2.5:1 from 30 to 54 MHz. The antennas handle 100 W in continuous-duty operation and 250 W intermittent commercial and amateur service (ICAS). It may be installed in several different configurations, offering a flexible approach to broadband frequency coverage. The antennas are delivered fully assembled. No tuning or adjustment is required.

In the vee-beam configuration, the antenna is unidirectional and offers significant gain at the higher frequencies. In the broadside/endfire configuration, the antenna is bidirectional or multi-directional, depending on frequency of operation. Typical radiation patterns are presented in Section 3.

Refer to Fig 1-1. Models 3402 and 3403 may be installed using a single mast. The antenna consists of a 50-to-800 ohm broadband transformer, two 100-foot radiating elements (50-foot elements for Model 3403), two terminations and two wire segments for connection to ground.

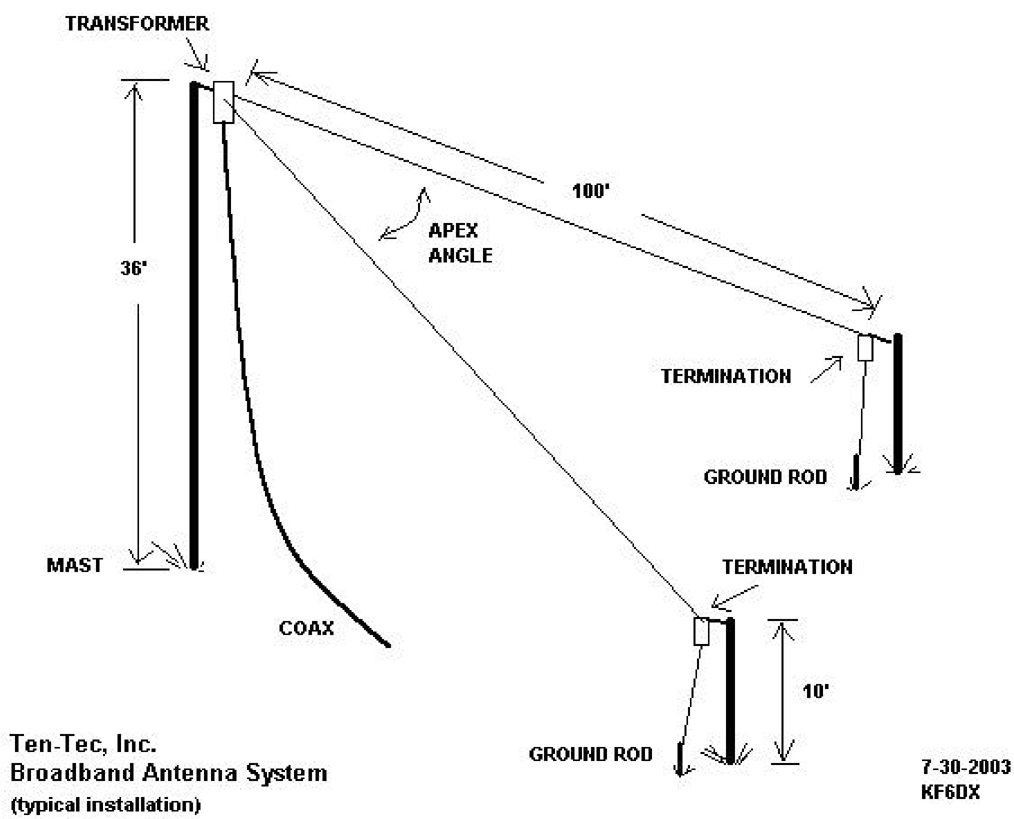

Fig 1-1: Model 3402 typical installation.

A. Brief Theory of Operation

Models 3402 and 3403 are nonresonant, travelling-wave antennas. That means that at any one position along a radiating element, values of current and voltage are not fixed, as they are in a standing-wave antenna, such as a resonant dipole. The antenna exploits a property of endfed wires one wavelength and longer: they exhibit gain at some angle to the axis of the wire and on each side of the wire, both fore and aft. A long wire thus has four major lobes in its radiation pattern and two or more minor lobes. See Fig 1-2. When an endfed wire is many wavelengths long, the directions of maximum radiation approach the axis of the wire.

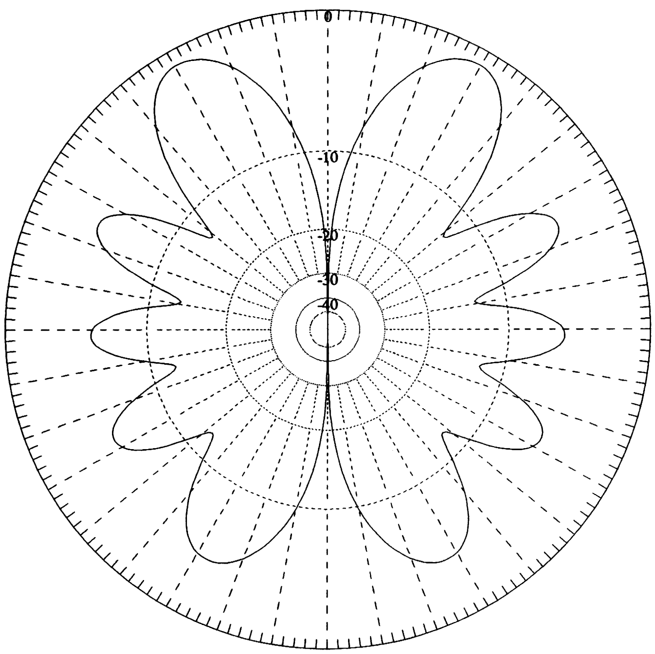

Fig 1-2. End-fed long-wire radiation pattern.

When two long wires form a vee and are fed in balanced fashion at the apex, pairs of major radiation lobes tend to reinforce, producing a single major lobe in each direction along a line bisecting the vee. See Fig 1-3.

Placing terminations to ground at the free end of each wire eliminates reflected waves from those ends, making the antenna broadband. Radiated energy comes only from the waves that travel from the feed point to the terminations. The terminations therefore also make the antenna unidirectional. See Fig 1-4.

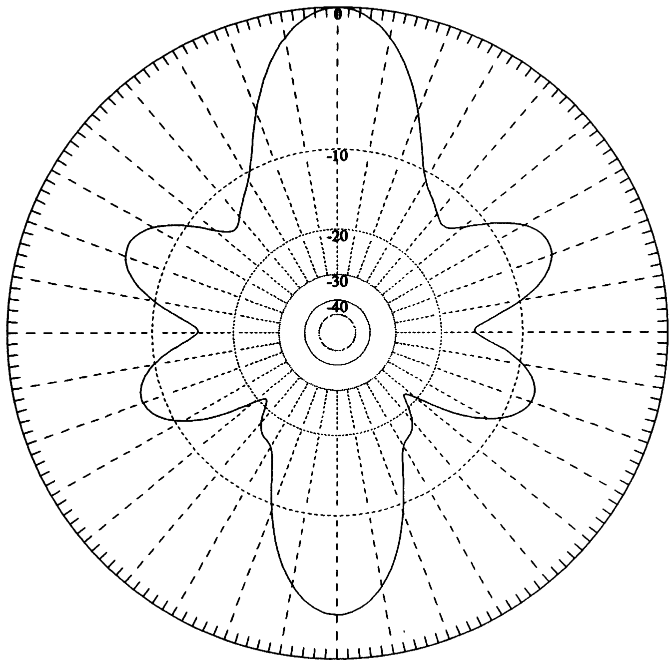

Fig 1-3. Unterminated, vee beam radiation pattern.

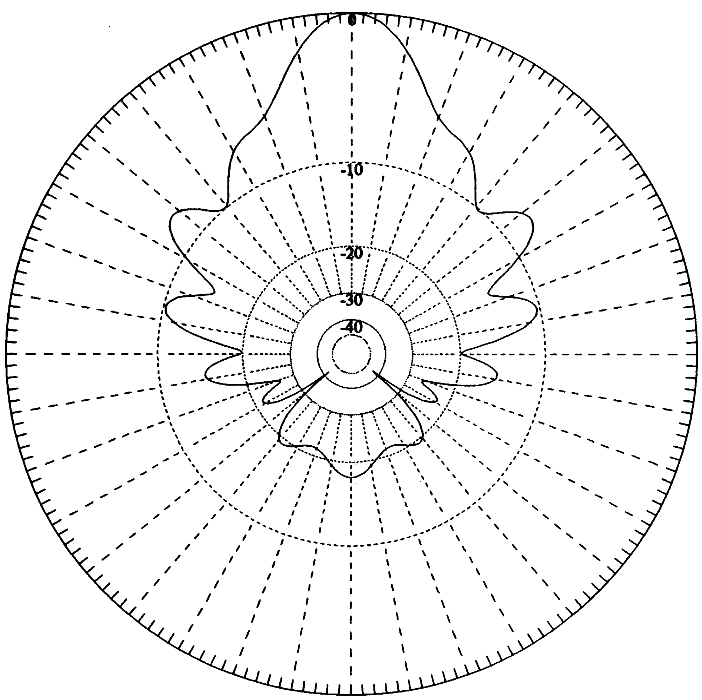

Fig 1-4. Terminated vee-beam radiation pattern.

The angle between the radiating elements is called the apex angle. The optimum apex angle depends on frequency. Apex angle may be optimized for a single frequency or a compromise reached for a group of very different frequencies.

Takeoff angle is the angle with respect to ground (altitude) at which maximum radiation occurs. With this and most other antennas, takeoff angle depends on installation height above ground.

When the Model 3402 is installed 0.5 wavelengths above ground in the vee-beam configuration, the takeoff angle is roughly 25 degrees. See Fig 1-5.

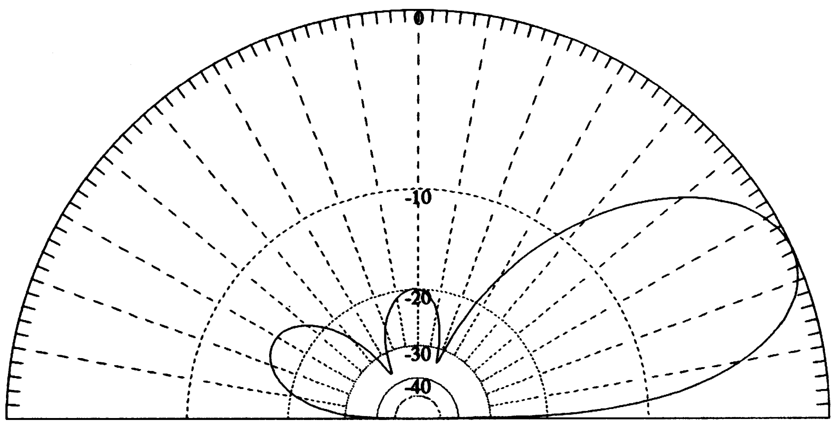

Fig 1-5. Typical elevation pattern at 1/2l above ground.

At one wavelength above ground, takeoff is about 15 degrees. See Fig 1-6. At greater heights, the major lobe breaks into two or more lobes as takeoff angle continues to decrease. That is generally not desirable. Consider the distance of the stations with which you wish to communicate and the optimum takeoff angle for that distance. Lower takeoff angles are generally better for longer distances.

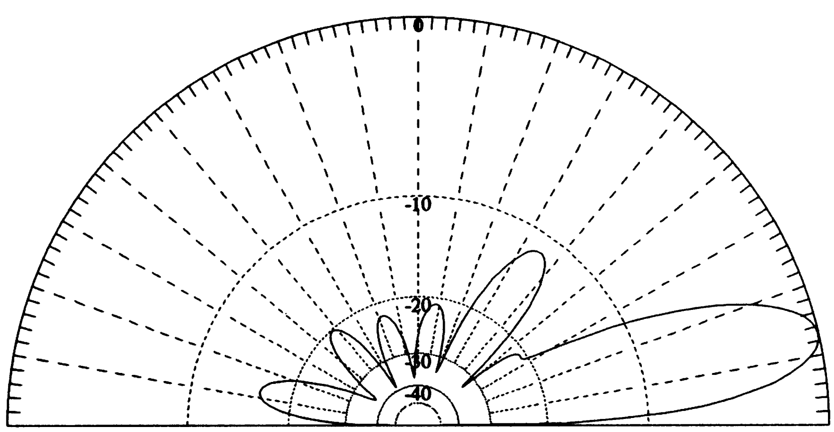

Fig 1-6. Typical elevation pattern at 1 l above ground.

The terminated vee beam exhibits gain over a dipole at frequencies where its elements are one wavelength or greater and when installed at one wavelength above ground. Fig 1-7 shows approximate gain figures assuming a one-wavelength height.

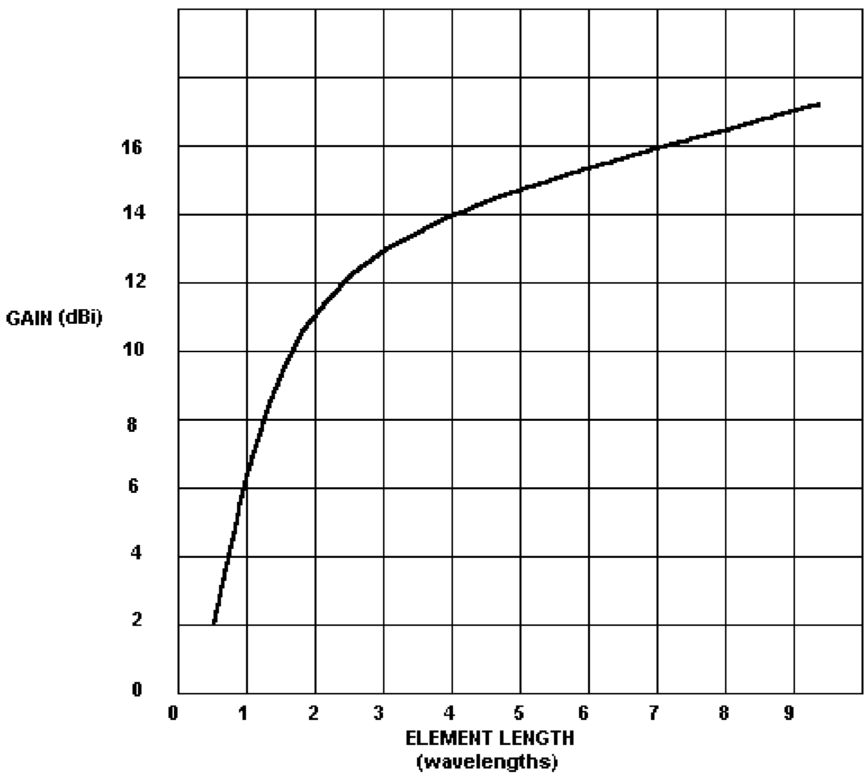

Fig 1-7: Approximate gain vs. length

B. Additional Materials You Will Need

Most configurations employ two copper ground rods for the two ground connections. Alternate configurations employ one or more ground radials. You will have to obtain either the ground rods or at least 180’ (90' for 3403) of 14 AWG (or larger) stranded copper wire to use as radials. You will also need a mast or vertical support of some kind. 30 feet should be considered a minimum height for the feed point. 60 feet is better because it will get you 3-4 dB more gain on the higher frequencies.

2. Technical Specifications

Input power rating: 100 W continuous duty; 250 W ICAS
Feed point impedance: 50 ohms nominal
Feed point VSWR: less than 2:1 typical 1.8-30 MHz, model 3402; 3.5-30 MHz, model 3403. Less than 2.5:1 30-54 MHz, both models.
Feed point connector: SO-239
Transformer impedances: 50 ohms feed point, 800 ohms antenna
Termination impedance: 400 ohms typical

Element length: 100 ft (50 ft 3403)
Wire type: 14 AWG 7/22 stranded copper-clad steel
(Specifications are subject to change without notice)

3. Preparations for Installation

Prior to installing the antenna, you must select a configuration and decide on a grounding method.

A. Choosing a Configuration

The two basic configurations are the vee-beam configuration and the broadside/endfire configuration. The vee-beam configuration provides gain over much of the HF range in a single direction. See Table 3-1.

The broadside/endfire configuration has a radiation pattern that is much like that of a dipole in the lower part of the HF range. See Fig 3-1. (Plane of wire is vertical in the figure.)

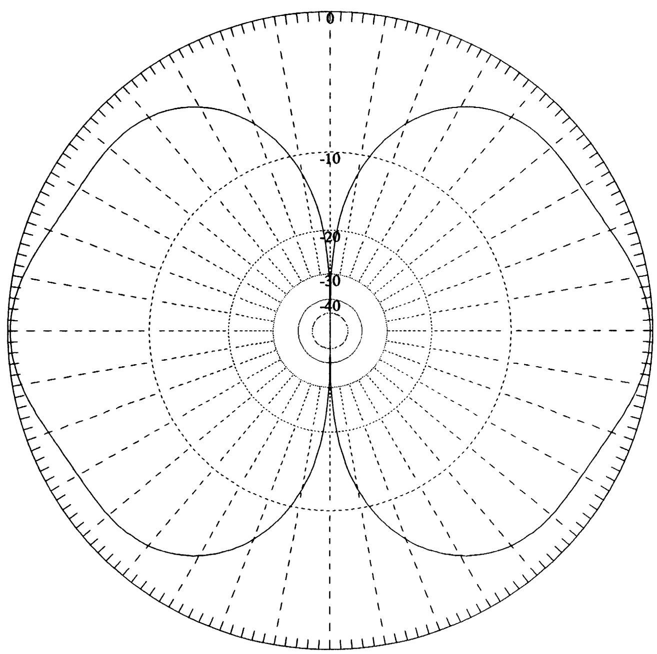

Fig 3-1. Typical broadside radiation pattern at lower frequencies.

Toward the high end of the antenna's range, the pattern becomes increasingly endfire, developing multiple lobes. See Fig 3-2.

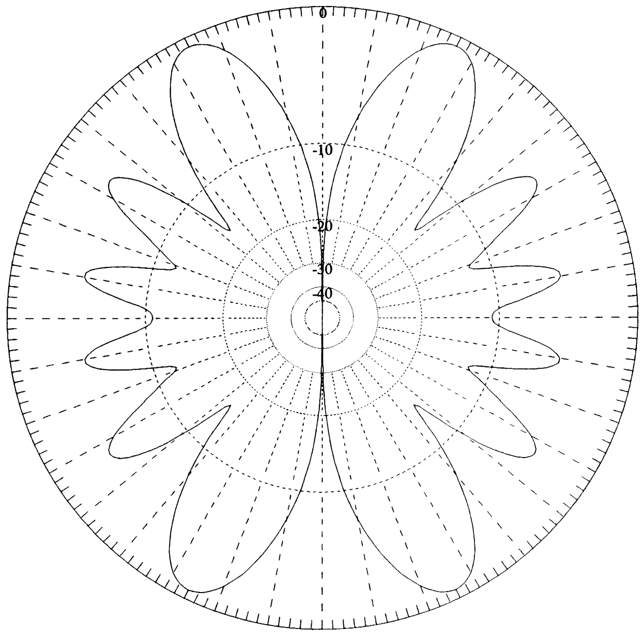

Fig 3-2. Typical endfire radiation pattern at higher frequencies.

If you choose the vee-beam configuration, you must select an apex angle—the angle between the radiating elements. The apex angle may be optimized for forward gain at a single frequency according to Fig 3-3a for the 3402 and Fig 3-3b for the 3403. To optimize gain over a range of frequencies, select a frequency midway between the extremes and use that as your index in the figures.

The footprint, or acreage, needed for any particular vee-beam configuration may be calculated once the apex angle is known. Refer to Fig 3-4. Dimension A is the distance between the feed point (mast) and the terminations on an axis at right angles to dimension B. Dimension A also depends on the difference in heights of the feed point and the terminations. Dimension B is the distance between the terminations.

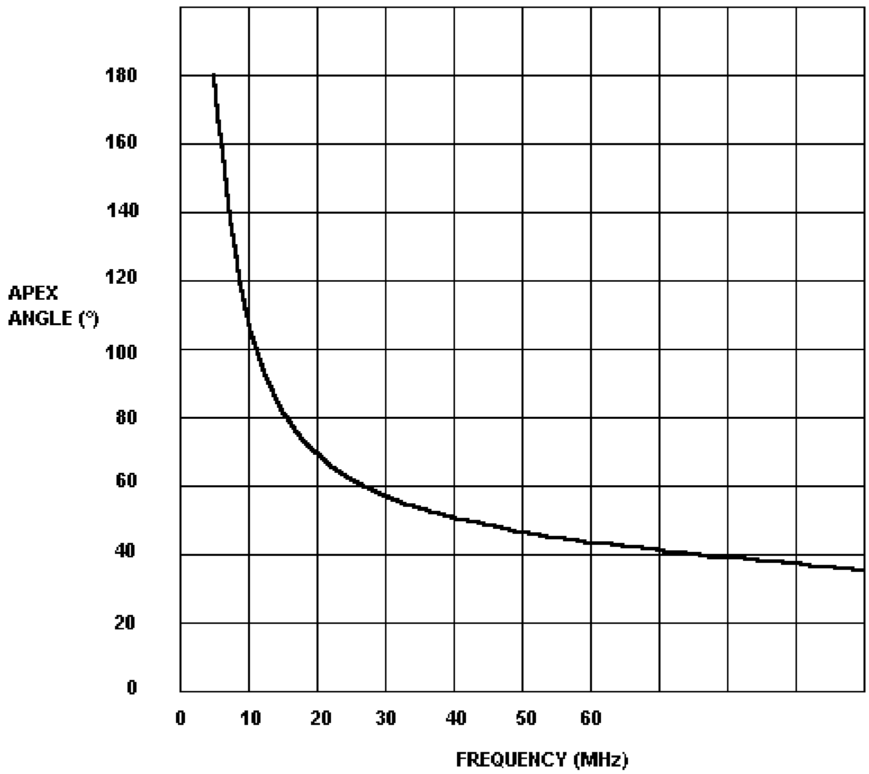

Fig 3-3a: Optimal apex angle vs. frequency, 3402

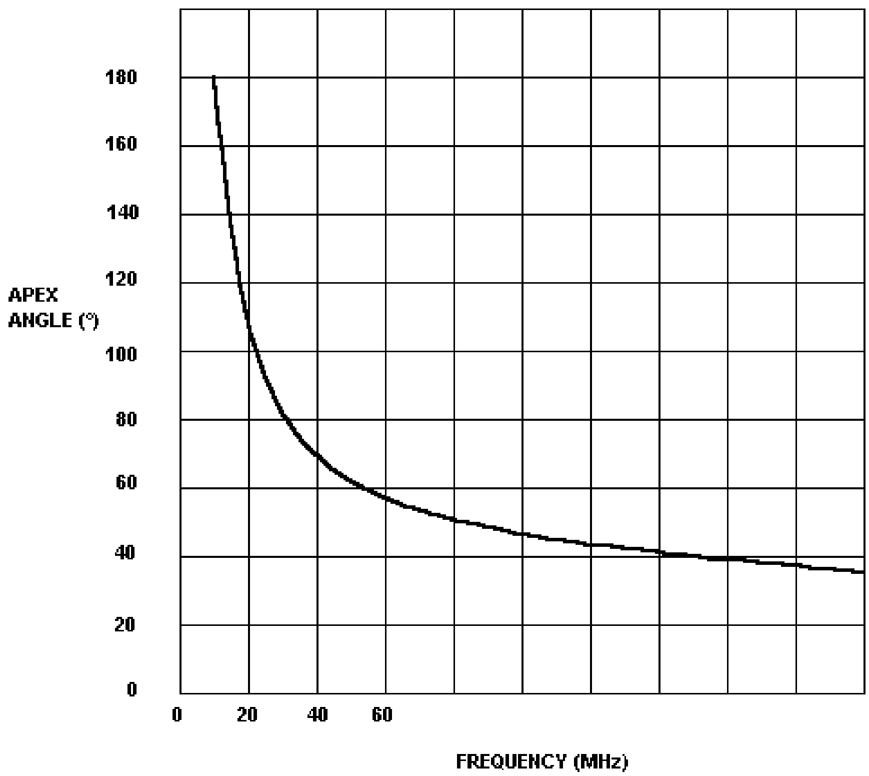

Fig 3-3b: Optimal apex angle vs. frequency, 3403

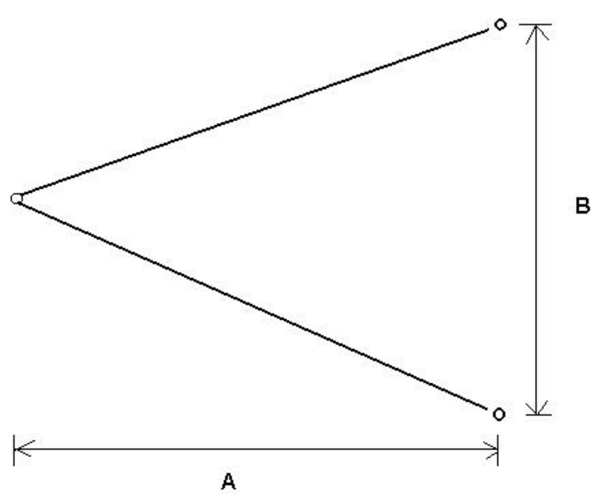

Fig 3-4. Overhead projection showing dimensions A and B of Table 3-2

With 100-foot radiating elements, dimension B may be exactly calculated using: $B=200\sin(\theta/2)$, where θ is the apex angle. Ignoring the difference in heights of the feed point and terminations, a minor factor when it is much less than 100 feet, dimension A may be calculated using: $A=100\cos(\theta/2)$. Below, Table 3-2 is a table of calculated values using 100-foot radiating elements. For footprint dimensions of the 3403 (50-foot elements), divide dimensions by two.

Table 3-2: 3402 antenna footprint dimensions

Apex Angle (°)	Dimension B (ft)	Dimension A (ft)
120	173	50
90	141	71
75	122	79
60	100	87
45	77	92

The broadside/endfire configuration is obtained by making the apex angle 180°. The antenna then resembles an inverted-vee dipole. If the antenna proves too large for the available space, it may be shortened as described in subsection C below.

B. Choosing a Grounding Method

The two choices for a grounding method are ground rods or radial counterpoises. When installing the terminations over moist soil, ground rods alone may be sufficient. For rooftop installations or locations with poor soil conductivity, ground radials should be used. In any case, ground radials will improve the performance of the antenna.

Eight-foot copper-clad steel ground rods are available at most hardware stores, along with the proper clamps. Get two of each to hold the ground wires from the two terminations.

To make ground radials, obtain 200 feet (100 feet for 3403) of 14 AWG, 7/22 stranded hard-drawn copper wire (Ten-Tec PN R3300) and at least two copper oval crimp sleeves to splice the radials to the ground wires.

C. Changing the Length of the Antenna

The radiating elements may be shortened to accommodate smaller available space, but *you must shorten them equally to maintain balance*. Shortening the elements will result in reduced efficiency and gain. The elements may be lengthened equally to achieve increased gain and better efficiencies.

Use copper oval crimp sleeves to splice the elements after alteration. Crimp sleeves may be secured by striking them with a hammer to compress them. Be sure to cover the crimps with silicone-rubber adhesive or a similar waterproof material to prevent corrosion.

4. Installation

CAUTION: *Do not attempt to install mast or antenna where the slightest chance exists that it can come into contact with electric power lines. Contact with electric power lines may be fatal!*

Install the antenna away from other conducting objects. Avoid running the radiating elements in parallel with or close to any large objects, conducting or not. Elevate the terminations as high as possible, using auxiliary masts or supports, if possible.

Placing a pulley at the top of the main mast and using a ¼-inch nylon rope to hoist the transformer facilitates lowering the antenna later for any feedline maintanence. That also allows you to place a strain-relief loop in the feedline so that it does not pull out of the PL-259 connector. See Fig 4-1.

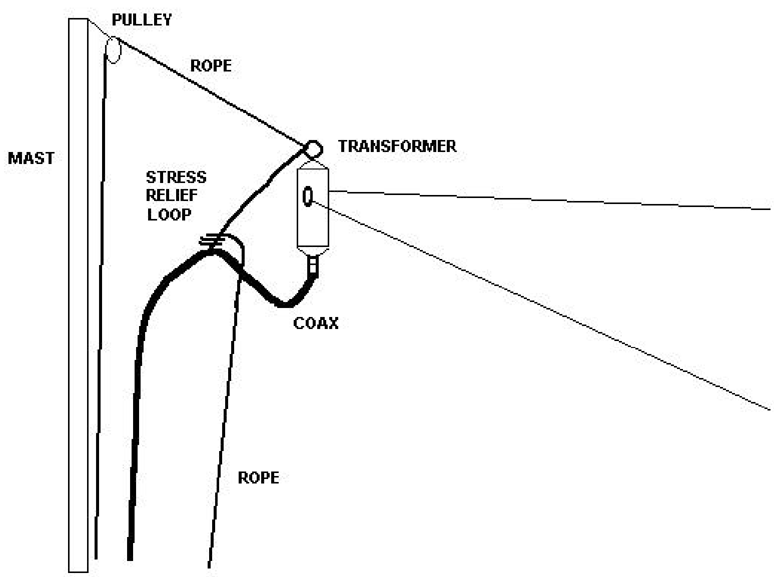

Fig 4-1. Recommended system of halyard and stress relief

For waterproofing, wrap the coaxial connector with electrical tape after the feed line is connected to the transformer. Cover the connection with a thin layer of silicone-rubber adhesive or similar waterproof coating.

Attach the transformer to the mast or halyard using only the large eyebolt on top. Tie off the terminations to their supports, or to a stake driven into the ground, or to the ground rod using only nonconductive rope. Take up the slack in the radiating elements by tying each termination using only the large eyebolt. Tying to the small eyebolt places stresses across the termination assembly and may result in damage.

Attach the free wire of each termination to the ground system or radial counterpoise. If radials are used, it is best to run them as directly as possible back toward the base of the main mast. Lay them on the ground or bury them about 6 inches deep if the land is to be mowed or if there is danger anyone would trip over them or otherwise come in contact with them.