# ham radio TECHNIQUES

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**Long, long ago,** in a galaxy far, far away, or so it now seems, the World Administrative Radio Conference set aside certain new, narrow, high-frequency bands for use by the Amateur Service. Since January a year ago, over sixty countries have permitted Amateur operation in one of these bands, 10.1 MHz to 10.15 MHz. But the United States — whose Amateurs spearheaded the effort at WARC to get the new bands — has dragged its feet on granting permission to operate in these bands. The reasons for the long delay make an interesting story, indeed.

Finally the combined efforts of the ARRL and a hot letter to the FCC from Barry Goldwater, K7UGA, opened the door and (as of this writing in September) it looks as if the 10-MHz band will be opened to U.S. Amateurs around the first of 1983, if not before. And that's good news for 1983!*

The 10-MHz band is full of interesting DX when conditions are good, and one of the first questions raised by prospective 10-MHz operators concerns antennas for the new band, particularly all-band antennas that will cover existing bands plus the new ones. That means coverage of the 160, 80, 40, 30, 20, 17, 15, 12, and 10 meter bands, now available on the bandswitch of many of the new transceivers!

## simple all-band antennas

The first all-band antenna that comes to mind is the well-known center-fed long wire (**fig. 1**). Used with an open-wire transmission line and an antenna tuner at the station, this simple antenna will work well on any frequency within the range covered by the tuner. (The tuner is sometimes called a Transmatch.) The tuner is coupled to the station equipment via a coaxial line and SWR indicator.

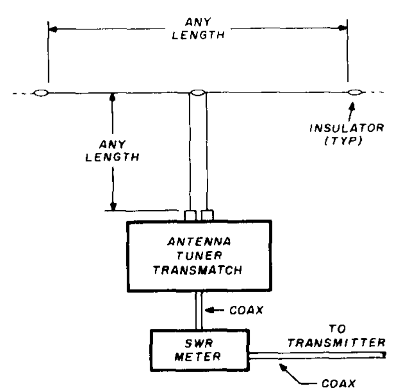


**fig. 1. A center-fed wire serves as an all-band antenna when used with a suitable antenna tuner located at the station. Lengths of antenna and two-wire transmission line are not critical as long as overall length of wire is at least one-quarter wavelength at lowest frequency used.**

A second simple wire antenna that will cover all the Amateur high-frequency bands is the end-fed wire (**fig. 2**). A pi-network composed of a rotary inductor and two capacitors matches the wire antenna to a 50-ohm system.

Users of the end-fed antenna know that under certain conditions the antenna will tune up well, but the shack will be full of rf and feedback. This can cause erratic operation of the equipment, TVI, and other unpleasant problems. The cause of the diffi-

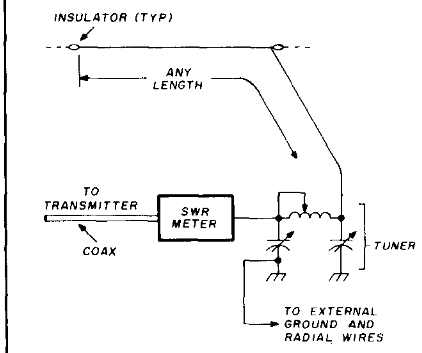


**fig. 2. End-fed, random-length wire with simple pi-network tuner serves as all-band antenna. A good ground system is required with this antenna.**

*As of 3 pm EDST, October 28, U.S. Amateurs were permitted use of 10.100-10.109 and 10.115-10.150 MHz using $A_1$, $F_1$ modes at a maximum power level of 250 watts.

culties is that the equipment is not at rf ground potential. Attaching a ground to the equipment usually doesn't help a bit, as the inductance of the ground wire upsets the situation even more. The use of quarter-wavelength radial ground wires cut to the operating frequency will solve this vexing problem. The radial ground wire is merely a length of insulated wire, free at the far end. It is cut to an electrical quarter wave at the operating frequency and affixed to the ground post of the equipment. The wire can be tossed on the floor behind the operating desk.

## the Australian broadband dipole

One of the best all-band antennas in use is the so-called Australian dipole, which I briefly mentioned in an article in *CQ* magazine, October, 1974. After this article, the antenna sank into oblivion, at least in the United States.

In spite of this seeming lack of interest, the unusual antenna has continued to be used by Amateurs and commercial point-to-point services in other areas of the world. It eventually caught the attention of D.W. Harris (A22BX), the Deputy Director of Broadcasting (Engineering) at Radio Botswana in Southern Africa.

In common with many developing countries, Botswana has internal communications difficulties. Roads are often poor in rural areas and the telecommunications networks are hardly developed. As a result, the news service of Radio Botswana is an important facet in passing information from remote districts to the capital.

Harris decided to use high-frequency SSB transceivers for this purpose — along with broadband antennas — with provisions for patching tape recorders into the transceivers. (Drake TR-7 transceivers were used with the SL-4000, 4-kHz passband filter.)

The problem of a broadband antenna which could be easily built and installed was formidable, as it had to provide less than a 2:1 SWR across the operating range. An article on the "Broadband Travelling Wave Dipole" appeared in the April, 1974, issue of *Amateur Radio* (Australia), which described an interesting antenna developed for use in the Australian Outback for the Flying Doctor radio service.

Harris and his staff built several Australian dipoles and tried them out with varying success. Finally, a modification of the original design produced a noncritical, wideband antenna which, with a special balun, showed less than a 2:1 SWR from below 3 MHz to over 20 MHz. The antenna was useful up to 30 MHz, as shown in the SWR plot of **fig. 3**.

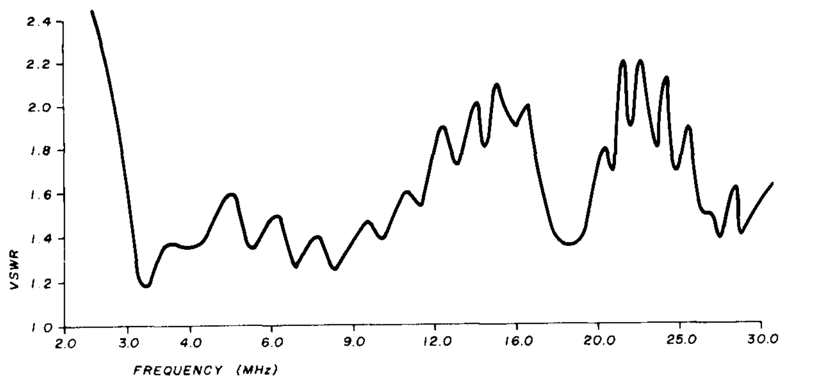


**fig. 3. Measured performance of Australian Dipole, showing VSWR plotted against frequency every 0.5 MHz from 6 MHz to 30 MHz.**

## the modified Australian dipole

A simplified diagram of the A22BX version of the Australian dipole is

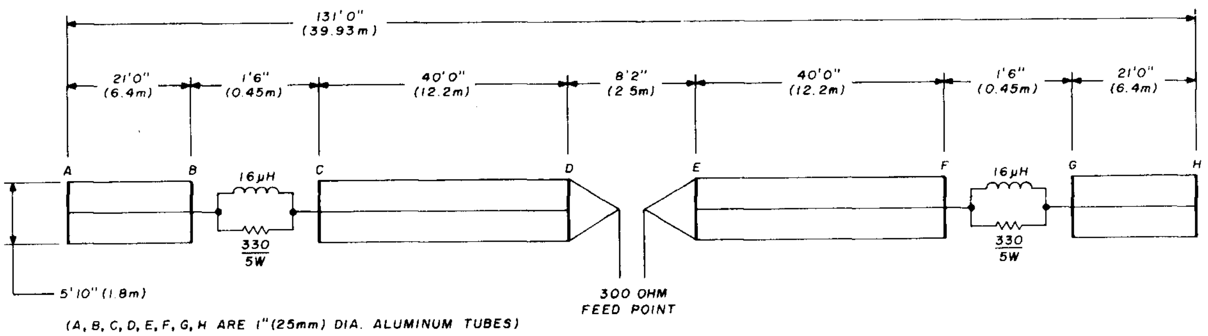


**fig. 4. Three wire "flat-top" with loading networks provides broadband service between 2 MHz and 30 MHz. Antenna is fed with balun and coaxial line.**

shown in **fig. 4**. Overall length is about 133 feet (40 meters). The antenna consists of a flat-top of three parallel wires, broken at intervals by simple loading networks placed in series with the wires. The feedpoint impedance of the antenna is about 300 ohms. A toroid transformer wound on an Amidon two-inch diameter red core was used to make the impedance transformation to a 50-ohm line (**fig. 5**).

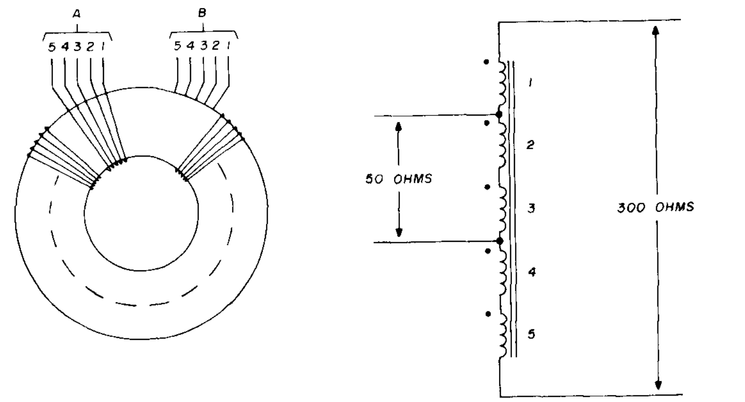


**fig. 5. Transformer is wound on iron-powder toroid. Fourteen turns, each composed of five parallel wires, are wound on the core. Turns are interconnected as shown at right to provide 5/2 turns ratio (6.25/1 impedance ratio).**

Details of antenna construction are shown in **fig. 6**. Hard-drawn copper wire is used for the flat-top to prevent stretching. The small networks are made of a 300-ohm, 5-watt composition resistor placed in parallel with a small inductor.

To hold the three wires of the antenna in position, yet allow easy handling on the ground, the networks are fastened to a framework that is big enough to attach the antenna wires to, as shown in the detail drawings. One-inch diameter PVC plastic conduit is used for the insulators. The aluminum spreaders were made from decorative aluminum L-shaped stock measuring about an inch wide and ½-inch thick, used for edging on Formica kitchen table tops. Small, 10-32 machine bolts, nuts, and hardware are used to hold the various strips and tubes together.

A22BX suggests using polypropy-

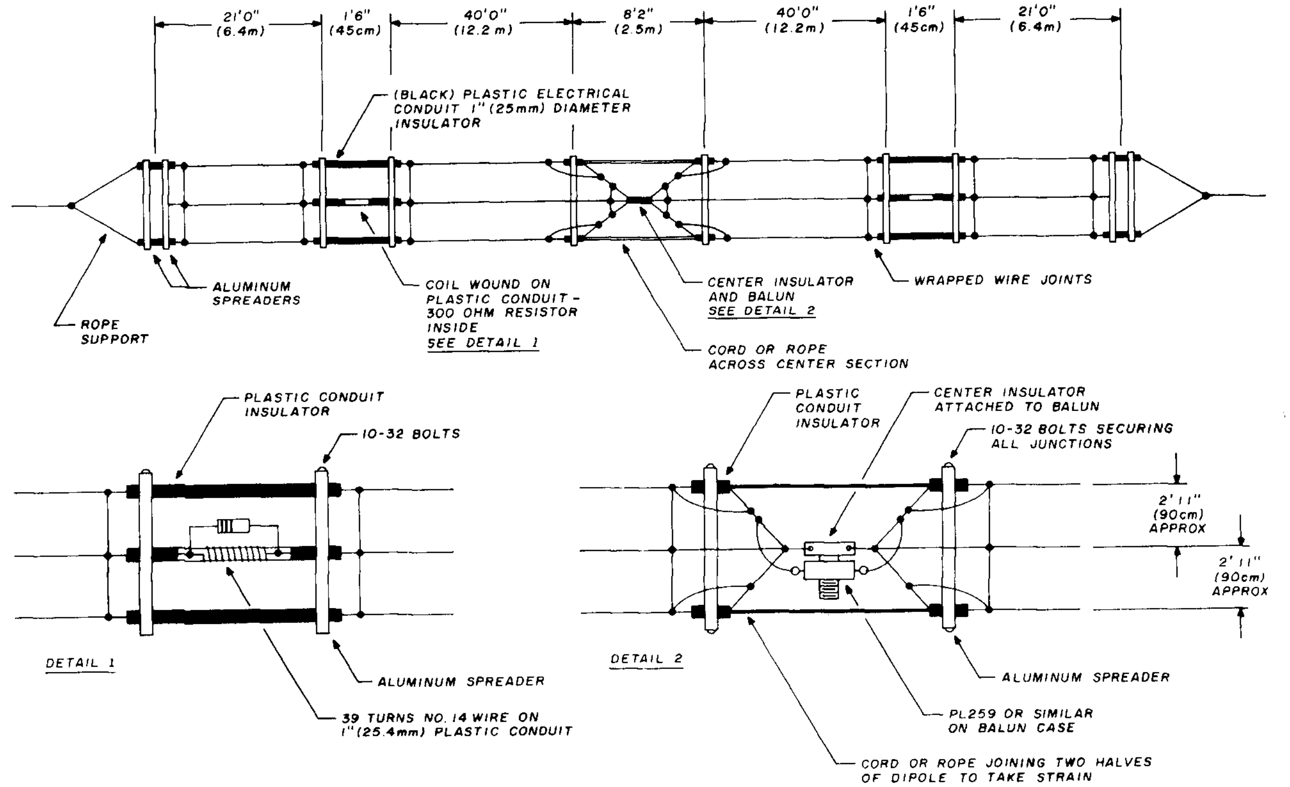


**fig. 6. Assembly details for Australian Dipole.**

lene plastic fiber rope in the antenna assembly to resist the effects of ultraviolet light. A suitable substitute rope is UV-resistant polyester material.

## antenna installation

The SWR curve shown for this antenna was measured through about 75 feet (23 meters) of coaxial line, and the antenna was suspended in the air at about 40 feet (12 meters). As can be seen, the SWR was excellent up to 15 MHz, rising between 15 and 16 MHz to 2.1:1, then dropping down to low values up to 21.5 MHz, where two SWR peaks at 2.2:1 appear. The SWR curve then gradually drops off to a low value at 30 MHz. Undoubtedly the antenna is also suitable for operation above 30 MHz, but higher frequency measurements were not made.

The SWR can be adjusted around 16 and 22 MHz by varying the height of the antenna above ground, and for a permanent installation, the ends of the Australian dipole can be varied in height to smooth out the SWR curve by taking advantage of ground reflection.

## the balun transformer

The matching transformer is wound on an iron-powder core having an outside diameter of two inches (5.08 cm). Inner diameter is 1¼ inches (3.18 cm). It is made by Micrometals Corp. and has the Amidon part number T-200-2. It is coded red, and has a permeability of ten. It is recommended for operation over the range of 1 MHz to 30 MHz. The core is also sold by J.W. Miller Division of Bell Industries as part number T200-2.

To prepare the core, wrap it with a layer of 3M brand (or equivalent) glass epoxy tape to prevent arcing between winding and core. A single winding composed of five parallel wires is placed on the core. No. 14 AWG Formvar-insulated (about 1-mm diameter) wire is used. Fourteen turns of the five-wire combination are wound on the core. The approximate length of wire used for each winding is about 5 feet (1.5 meters).

It is easier to wind the core than to explain how it's done. One set of wire ends is held in a vise and the five wires are smoothed out until they lie parallel. The parallel group of wires is stretched to remove kinks and then removed from the vise. The wires can be wound on the core all at once, or three wires can be wound on, followed by two, if that seems more convenient. In either case, the windings should all lie together.

When completed, continuity of each winding can be checked with an ohmmeter and the wire ends marked for convenience with a drop of epoxy paint. The last step is to interconnect the windings to get the proper transformation ratio. The windings are connected in series and the 300-ohm termination taken from the ends of the windings. The 50-ohm input points are tapped off between the ends of the second and third windings. This provides a turns ratio of 5:2 and an impedance transformation of 6.25:1.

When the transformer is completed it is given a coat of casting resin to protect it from the weather.

The transformer is attached to the center insulator of the antenna and a coaxial receptacle (SO-239), or a waterproof type-N connector, affixed to the balun terminals, and mounted to the center insulator.

When the antenna is completed, it should be raised in position and adjusted to provide the lowest value of SWR in the most important frequency regions of operation.

*Note:* This antenna is based upon a design by Dr. R.J.F. Guertier and G.E. Collyer of Antenna Engineering Australia (Pty.), Ltd. and was described in *Amateur Radio* (Australia), April, 1974. Information on the Australian Dipole is gathered from issues of *Amateur Radio*, the monthly publication of the Wireless Institute of Australia, Box 150, Toorak, Victoria 3142, Australia.

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