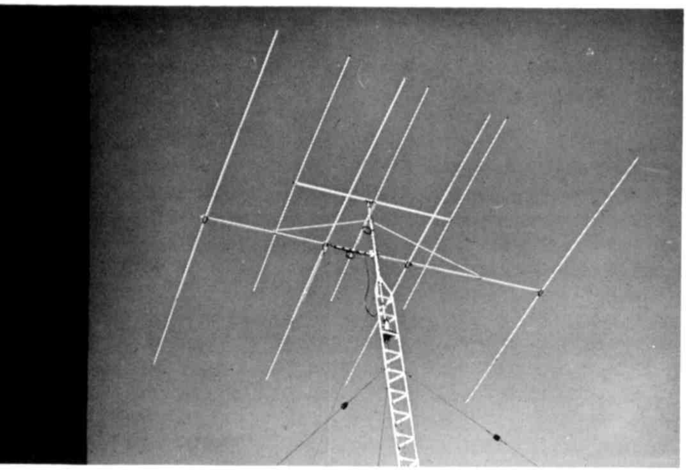

single feedline for multiple antennas

A decoupling scheme for exciting separate antennas with one transmission line

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Many articles have appeared that discuss the merits of single-band rotary beams versus those featuring multiband operation. One popular solution to multiband antenna operation is the tribander. This approach has two disadvantages: Element spacing can be optimized for only one of the three bands, and resonant traps and impedance-balancing devices introduce ohmic losses. Both effects can't help but compromise overall antenna efficiency.

Another solution to multiband antenna operation is the log periodic array. While theoretically the most satisfying solution, the log periodic antenna isn't too practical for most amateurs because of cost and structural complexity. In addition, the size of the log periodic antenna diminishes in its effect as frequency increases, while its gain remains essentially constant.

Still another multiband antenna approach uses interlaced elements on a single boom. This scheme permits more optimal element lengths, reduced ohmic losses, and proper spacing with minimal element interaction. Still, the interlaced beam is tricky to adjust and clumsy to install.

The only real solution to effective multiband antenna operation is to use a separate antenna optimized for each favorite band. This implies the use of separate feedlines for each antenna, or complex remote-control circuits for transferring a single transmission line between antennas.

This article describes an efficient method of feeding separate antennas on two or more bands with a single coax cable using a well-known principle of transmission-line theory. Superior antenna performance can be obtained at moderate cost.

economic considerations

A point often overlooked is that you can purchase three separate antennas of excellent mechanical and electrical quality for nearly the same price as a 20-, 15-, and 10-meter tribander. In fact, when considering only 10 and 15 meters, you can own separate 4-element yagis on each band for just a little more than the list price of one of the new 3-element dual-band antennas. Thus for a comparable investment, it's quite easy to achieve far superior performance in terms of measurable forward gain, directivity, and f/b ratio together with an exact impedance match; not to mention the absence of weather-susceptible traps. Moreover, such antennas can be home constructed using standard catalog boom-and-mast hardware for even greater savings.

At the risk of being accused of beating the cost issue to death, I'd like to make one more point. Consider that the price of a couple hundred feet of *good quality* coax with connectors comes quite close to that of a good commercial 3-element 10-meter beam. If you add the relays, control wiring, and switches necessary for separate antenna selection with a single feedline, the feed-system cost will be even higher.

the gimmick

A review of basic theory shows that, in the case of a half-wavelength transmission line, voltage and current are identical at the input and output terminals of the line. Hence the input impedance of any line, regardless of its characteristic impedance, is exactly the same as the load impedance, providing the line length is an *exact multiple of a half wavelength.* Such a line, therefore, may be used to transfer an impedance to a new physical location without changing the line's intrinsic characteristics. A typical application of this principle to achieve common-line feed for two different single-band antennas is shown in **fig. 1.**

Assume that each antenna has been individually adjusted to reflect 52 ohms pure resistive load at each respective nominal operating frequency, f_c. The 10-meter yagi is connected in parallel with the 15-meter yagi; hence it is also connected to the main feedline via a short length of coax. This interconnecting piece acts as our simple decoupling gimmick, which is electrically one-half wavelength long at f_c = 21.3 MHz of the lower-frequency antenna.

At 21 MHz the 10-meter yagi reflects a complex load consisting of $X_C + R$, with a net impedance much higher than 52 ohms, because its resonant frequency is

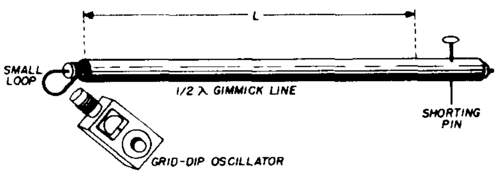

fig. 2. Test setup for determining appropriate length of the decoupling gimmick. Length, L, is trimmed for the operating frequency of the lower-frequency antenna.

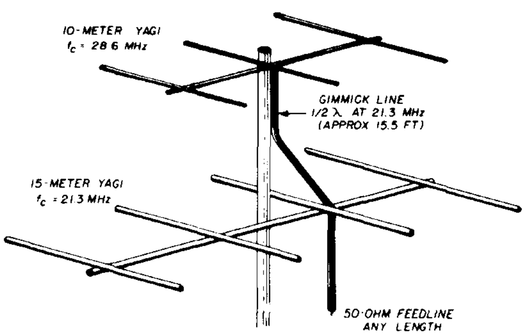

fig. 1. Decoupling method for isolating two stacked beam antennas. The 1/2-wave gimmick may be coiled into a loop and fastened to the mast or to the boom of the higher-frequency array.

far removed from 21 MHz. This same net high impedance is repeated one-half wavelength away (at 21.3 MHz) across the input terminals of the 15-meter yagi. The 15-meter beam reflects a much lower load (52 ohms) to the main transmission line; so the 15-meter beam absorbs power, while the 10-meter beam accepts essentially no power.

At 28 MHz, the 15-meter yagi reflects the much higher net impedance consisting of $X_L + R$. When operating on 10 meters the 10-meter yagi absorbs power, while the 15-meter yagi accepts virtually no power. The interconnecting gimmick line looks simply like a short continuation of the main transmission line.

construction and installation

Construction of a decoupling gimmick is very simple, as it is nothing more than a piece of coax trimmed to a fairly critical length. As a start, consider overall length to include all connections; i. e., coax fittings, terminal lugs, etc. Cut a piece slightly to the high side in length using:

$$L = \frac{500}{f_{MHz}} \times \text{velocity factor}$$

where $f_{MHz} = f_c$ of lower-frequency antenna

Install appropriate terminals or coax fittings to one end only. At this same end, temporarily provide a small loop, either by bolting terminals together or by fastening a ¾-inch-diameter loop to a coax fitting. The setup is shown in **fig. 2.** Short-circuit the opposite end by driving a large pin or nail through both shield and inner conductor. Using a grid-dip oscillator with a calibrated receiver, determine the resonant frequency of the initial length of cable. Then change the position of the shorting pin in gradual steps until the desired f_c is obtained. Cut off the excess cable, install appropriate fittings, and your decoupling gimmick is complete.

If your antennas are spaced closer together than the overall decoupling gimmick length, form the excess cable into a coil about 8 inches in diameter. Tape the coil to the mast or to the boom of the higher-frequency antenna.

experimental data

My installation, consisting of 10- and 15-meter gamma-matched beams, is shown in the photograph. The antennas are stacked 5 feet apart and consist of 3 elements on a 10-foot boom for ten meters and 4 elements on a 21-foot boom for 15 meters. Several experiments resulted in the following data.

Each antenna was tuned individually while completely divorced physically from the other. The data, shown in **table 1**, was acquired using a home-made swr bridge and field-strength meter.

table 1. Measured data using home-made test equipment. The standing-wave ratio was unity at fc.

antenna	forward gain (dB)	fc (MHz)	f/b ratio (dB)	bandwidth for 1.75 swr (kHz)	horizontal beamwidth at 3-dB points (deg)
10-meter beam	8.1	28.6	23	950	50
15-meter beam	9.3	21.27	27	600	43

Next, both antennas were mounted in final position on the mast. Alternately, one yagi was excited directly with the other completely disconnected. Rough data was taken as above, and results were essentially identical except that the 10-meter yagi was detuned; its resonant frequency was about 50 kHz higher.

The decoupling gimmick was installed, and the data in **table 1** was rechecked. Results were again identical, except that the 1.75:1 swr bandwidth decreased about 75 kHz for each antenna. This was considered to be well within usable limits of operation.

A reflected-power meter was inserted between antenna terminals and connecting lines. With moderate power applied, forward power to each *off-frequency* antenna was small compared with total transmitter output; in each case, reflected power was nearly equal to forward power. This confirmed that the decoupling scheme was indeed providing proper antenna isolation.

conclusion

The system described has been in operation for nearly two years. Many notable DX stations around the world will attest to consistent signal punch, notable scores in DX competitions, and distinct recognition in rare-country pileups. This system has made significant contributions toward my list of confirmed countries in the ARRL DX Century Club listing.

ham radio