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BNC Connectors Handle Switching in a Flexible Antenna Tuner

This simple matching network can help you feed RF power into just about anything—and it really *is* plug-and-play.

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You can electrically rearrange inductors and capacitors to get maximum mileage out of expensive antenna-tuner parts—easily. This article shows how to use BNC connectors to handle antenna-tuner switching chores. (You can use RF connectors other than BNCs, but BNCs are reliable and offer quick connect/disconnect unobtainable with other common connector types.) Fig 1 shows the arrangement I use: four BNC connectors (J1, J2, J3 and J4), an air-dielectric variable capacitor (C1), a roller inductor (L1) and an air-core, tappable inductor (L2). Fig 2 shows how everything looks in assembled form.

Getting the Right Parts

A self-supporting, air-core coil (Miniductor or equivalent) works well at L2; a toroidal-core inductor wound on a powdered-iron core appropriate for the frequency range (-2 material for 2 to 30 MHz; -6 material for 10 to 60 MHz) would work well, too. The roller inductor I used at L1 is a luxury. Sometimes you can obtain these at flea markets for affordable prices.

The capacitor you use may limit how much power your antenna tuner can handle. Wider capacitor plate spacings allow higher RF voltages before arcing

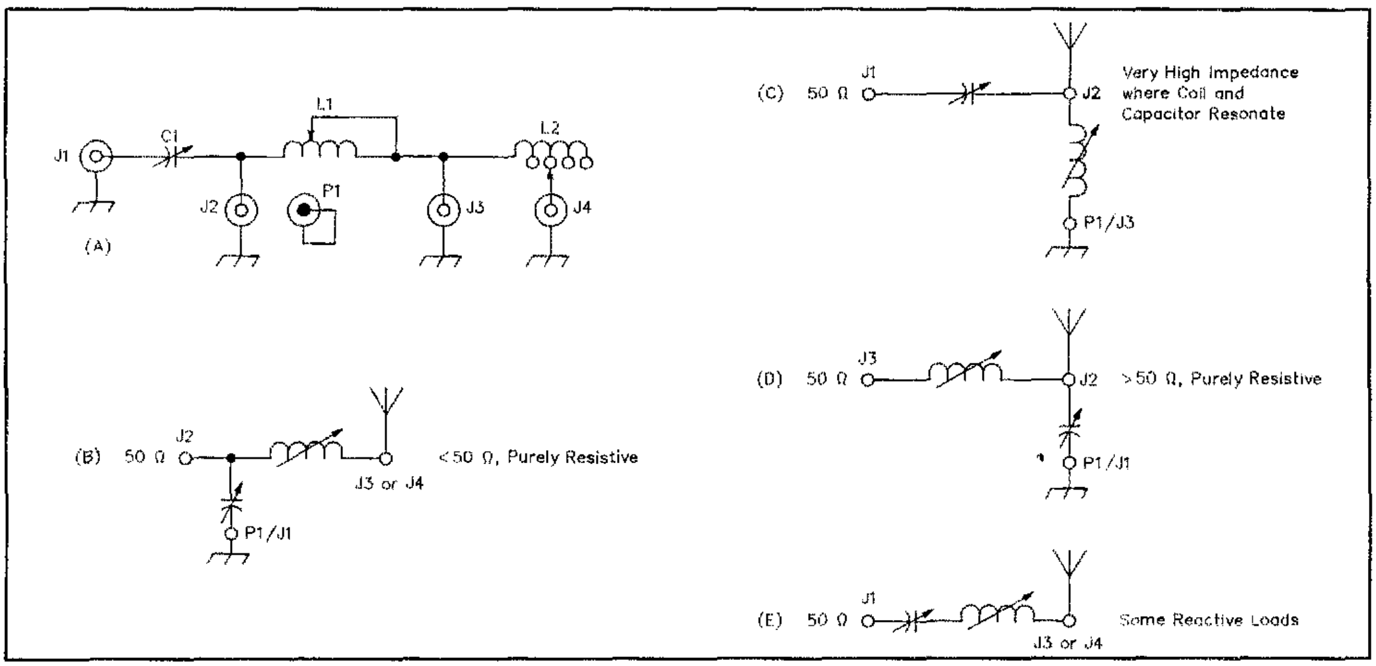

Fig 1—Zack Lau's flexible antenna tuner (A) uses BNC jacks and one shorted-plug jumper (P1) for easy, efficient switching between matching configurations. No jack is labeled INPUT or OUTPUT because of the network's flexibility and reversibility. B through E show the four LC networks possible with this component arrangement, including P1's role (if any) in their implementation. The load characteristics shown at B through E are approximations only. The best way to adjust this tuner is to experiment with various configurations and settings until you achieve minimum reflected power or SWR.

The component values below are those used in the tuner pictured in Fig 2; you need not duplicate them (or the particular parts used) exactly. Ocean State Electronics (PO Box 1458, Westerly, RI 02891, telephone 800-866-6626); Fair Radio Sales (PO Box 1105, Lima, OH 45802, telephone 419-223-2196 or 227-6573) and Surplus Sales of Nebraska (1315 Jones St, Omaha, NE 68102, telephone 402-346-4750), among other *QST* advertisers, carry coils, capacitors, connectors and fasteners suitable for this project. And don't forget flea markets—scrounge!

C1—250 pF, exact value not critical.
J1-J4—Chassis-mount coaxial jack, Teflon-dielectric BNC recommended.
L1—Roller inductor, approximately 10 µH, exact value not critical.
L2—Approximately 30 µH, exact value not critical. The coil shown in Fig 2, a PI DUX 1212A, may have been discontinued; it consists of 2¾ inches of 1½-inch-diameter, 16-turns-per-inch stock wound from #16 wire. A 2¾-inch-long piece of Barker & Williamson 3055 stock would be a close substitute.
P1—Shorted coaxial plug to match J1-J4.

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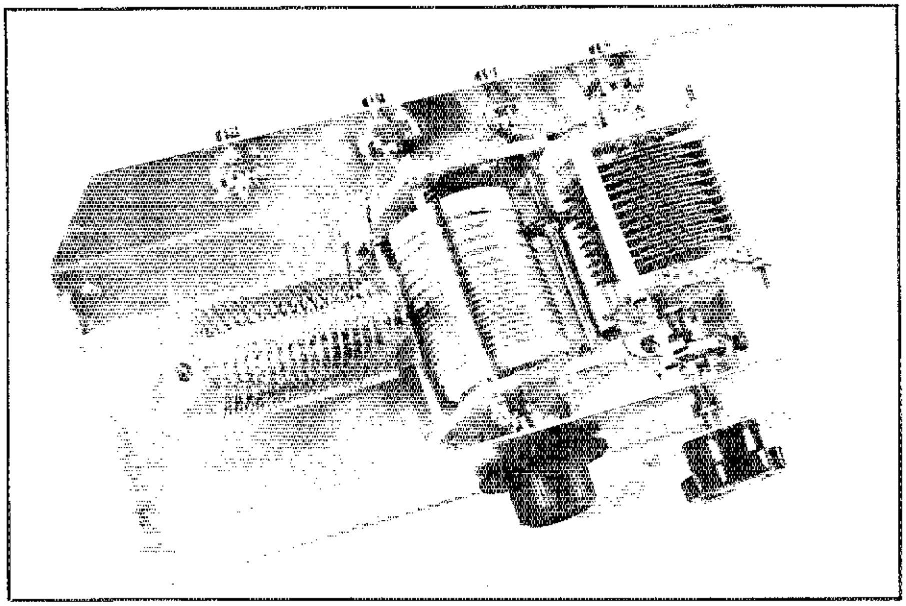

Fig 2—The prototype version of the Fig 1 circuit. From left to right, the jacks are J4-J1; the components are L2, L1 and C1. The tap clip on L2 is an Ocean State Electronics #3942.

occurs, but arcing at the circuit's RF connectors may be the limiting factor in many cases. BNC connectors are rated to withstand 500 volts. (Actually, it's better that the connectors arc first if arcing occurs at all, because connectors can be replaced cheaply. Arced-over, carbonized capacitors are sometimes repairable, but only with a lot of work.) I strongly recommend using Teflon-dielectric connectors in this application. Avoid bargain connectors; jacks containing cheap plastic insulation have been known to bubble and melt in the ARRL lab!

In addition to the jacks called out in Fig 1, you'll need one shorting plug (P1) to complete some matching configurations. Commercial shorting plugs, complete with chains that allow the plug to be made captive, are available (military number CW-159, available as Amphenol 31-17 and Kings KC-89-62, for instance), but you can save money and time by making your own.

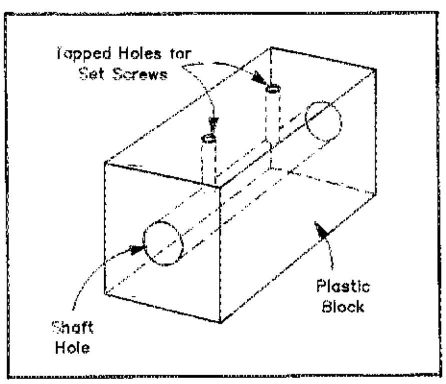

Fig 3—Can't locate a shaft coupler? Make your own out of an acrylic-plastic block. Drill a hole for the shafts through a small block of plastic. Then make two more holes, threaded to take setscrews, that intersect the shaft hole. You can make knobs for odd-sized shafts using much the same approach.

Building It

Perhaps the biggest advantage BNC-jumper switching offers over multiposition switches is short lead length, as Fig 2 shows. I positioned the parts so *short* pieces of copper strap and wire can connect everything together. This sure beats wiring multisection switches!

If you use a solenoidal inductor at L1, be sure to preserve its Q—that is, keep its RF losses low—by mounting it away from metal enclosure walls by at least its diameter. Likewise, *do not* build your antenna tuner into an iron or steel box! An iron or steel enclosure can raise a solenoidal coil's losses sky high. And don't use steel clips in making connections to L2—use brass or copper instead.

Some matching configurations require that you not ground one or more of the network components, so be sure to maximize your network's flexibility by insulating C1, L1 and L2 from the chassis and ground. I mounted C1 and L2 on ½-inch-square plastic bars. (The coil I used for L2 includes a plastic mounting plate; you can add a plate to air-wound coils that don't include one.) Like most roller inductors, the part I used at L1 required no additional insulation because its mounting brackets are insulated.

Variable components insulated from ground must be adjusted via nonconductive shafts or couplers. L1's shaft is insulated from the rest of the coil, but C1's shaft is connected to its rotor. In my tuner, I adjust C1 via a relatively expensive shaft coupler (Ocean State Electronics SC39006), but you can machine a cheaper plastic equivalent as shown in Fig 3.

Tuning the Tuner

Using the tuner is easy: First, experiment with the tuner's configuration and settings to maximize received noise. Then, through a series of short, identified test transmissions, experiment further to minimize your system's reflected power or SWR. You can easily add external inductance by installing BNC connectors on both terminals of your add-on inductors and plugging them into the network as necessary.

One challenge remains unmet with this antenna tuner design, though: an elegant way to parallel capacitance with C1 for a network that will match *anything* at MF/HF. Binding posts and switches are obvious solutions, but is there a better way? QST

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