Low-Pass Antenna Tuner

Match your antenna while reducing harmonics with this unique design.

by J. Frank Brumbaugh KB4ZGC

Most commercial and home-brew antenna tuners use essentially the same T-circuit—two variable capacitors in series with the RF, and a tapped or rotary inductor from the junction of both capacitors to ground. Obviously, this circuit works well. It can transform a wide range of impedances to match the nominal 50 ohm output of modern solid-state transceivers over a broad frequency range, from 160 or 80 meters through 10 meters.

However, it also has some disadvantages. It is a high-pass filter configuration and does nothing to reduce the amount of harmonic energy reaching the antenna. Construction is somewhat complicated in that both capacitors must be insulated from the cabinet. Under some impedance matching conditions, the set screws in the control knobs can "bite" your fingers with RF. Also, the cost of high quality variable capacitors and the difficulty of finding them today is discouraging.

There is a simple way of eliminating all these disadvantages while retaining the wide frequency range and impedance matching ability. This circuit is not new—it has been used by a few hams for years—but for some reason it has not received the publicity in ham literature that it deserves.

The Circuit

See Figure 1. This low-pass antenna tuner schematic retains a simple T-configuration. Now, however, the circuit forms a low-pass filter that reduces harmonic energy falling in the television channels by up to 20 dB. Only one variable capacitor is used, and its rotor is grounded, eliminating the possibility of RF biting one's fingers. A center-tapped inductor is in series with the RF, and the center tap is connected to the stator of the shunt-tuning capacitor. Both sections of the series coil are tapped every two turns, and the taps are selected by a pair of rotary wafer switches mounted directly to the grounded panel.

Theory of Operation

Selecting various coil taps with the rotary switches and varying the setting of the variable capacitor, much in the same way the standard tuner is adjusted, changes the operating frequency and impedance transformation ratio. This makes it possible to tune out any reactance, bringing the SWR down to 1:1, keeping the transceiver—and its owner—happy.

Because one tap point on each switch is connected to the center

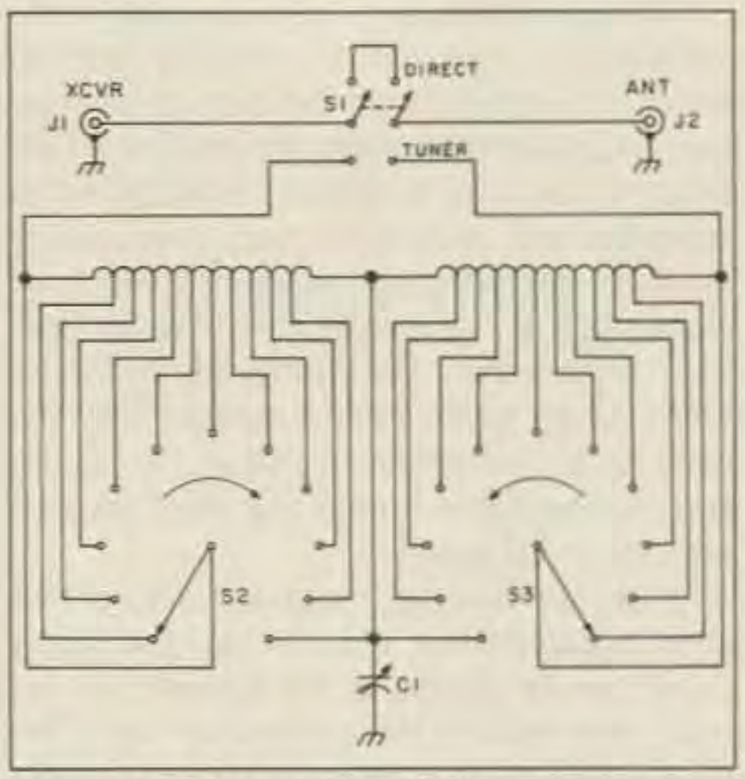

Figure 1. Schematic for the low-pass antenna tuner.

tap of the inductor, it is possible to change the circuit from a T- to an L-circuit with a choice of inductive or capacitive input. This lets you use the tuner with low or high impedance end-fed antennas, including random wires. This feature, impossible to achieve with the standard T-circuit, is handy for Field Day, and could be invaluable in emergency operation with a makeshift antenna.

Construction

A shielded metal box or an enclosure made of printed circuit board material should be used. However, this tuner will function equally well "in the open" on a breadboard. Because this unit is designed for the 3–30 MHz range, lead lengths are relatively unimportant.

A single length of air-wound inductor (Barker & Williamson or Airdux) with a total inductance of 35 to 40 µH, or a pair of tapped toroids (T106-2 or equivalent) will work equally well in this circuit. Both coil stock or toroid cores should be chosen with the power level of your rig in mind, of course. I use a Kenwood TS-440S "barefoot," so I chose a "50 watt, 80 meter" plug-in coil of the 5-pin type common in the 1940s and 1950s, which I found at a hamfest for 50¢. It has an inductance of about 17 µH each side of the center tap—34 µH total. It is tapped every two turns.

The shunt-tuning capacitor should have a plate spacing of at least 0.05" for use with the usual 100 watt transceiver. The two wafer switches are ceramic, single pole, 11-position, with shorting contacts. I used a surplus 140 pF tuning capacitor from a BC-610 tuning unit, another hamfest prize purchase. However, a 100 pF capacitor should be sufficient.

The parts layout can be whatever the builder prefers, though the logical arrangement is to mount the wafer switches in a horizontal line on the panel, with the capacitor mounted between them, or slightly above or below the wafer switches.

A miniature DPDT toggle switch, rated 6 amperes at 120 VAC, is included for ease in inserting or bypassing the tuner in the transmission line. This is not required, but it eliminates unscrewing and rescrewing a lot of coaxial jumper cables when changing from using the tuner to feeding the transmission line directly.

Finding the Parts

Check out your junk box. Ask local hams and at your next ham club meeting. Scrounge the flea markets at hamfests. These are the cheapest ways of getting the coil and capacitor.

If all else fails, suitable air-wound inductors are available from *Surplus Sales of Nebraska, 1315 Jones, Omaha NE 68102.* Suitable variable capacitors are available from *Fair Radio Sales, P.O. Box 1105, Lima OH 45802.* Radio Shack and numerous mail order electronic parts dealers can supply a metal enclosure, knobs, wafer switches and RF connectors. *Radiokit, P.O. Box 973, Pelham NH 03076 (603) 635-2235* is another good source of wafer switches, coils (B & W Airdux series) and large variable capacitors. The capacitor plate spacing and the size of the coil will depend on the amount of power you wish to run through the tuner. For example: If you are running under 100 watts try using Radiokit coil # 1606T or 1608T (2" diameter B & W Airdux) and variable capacitor #21140 (Millen) or #149-6-1 (Cardwell).

Parts List

C1	100 to 150 pF variable capacitor, 0.05" spacing.
J1, J2	SO-239 or other RF connector.
L1	35-40 µH coil, center-tapped.
S1	DPDT toggle switch.
S2, S3	Single pole, 11-position ceramic wafer switch, shorting contacts.

Operation

Connect the low-pass antenna tuner between the antenna transmission line and an SWR meter which is connected to the output of your transceiver. Set C1 to half

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capacitance, and set both switches to about the center of their ranges.

With the transceiver adjusted for a few watts output on CW, key the transceiver and adjust both wafer switches for the lowest SWR indication. Then, adjust C1 while changing the position of one or both wafer switches, one position at a time, until the SWR is as low as possible. This usually will be 1.1:1 or lower with most installations.

There may be more than one pair of switch positions which produce an SWR below 1.5:1. Although 1.5:1 is satisfactory for all modern transceivers, changing one or both switches a single position one way or the other should allow adjusting C1 for an even lower SWR indication.

Although it may be necessary to change the positions of the wafer switches when going from one end of 80 meters to the other, on the higher bands a slight adjustment of C1 should allow the SWR to be brought back to 1.1:1.

Conclusion

The low-pass antenna tuner is an efficient, wide-range, easy-to-build-and-use accessory for your station. It covers the 3–30 MHz range. It can also be used as an L-circuit tuner to feed random wires as well as low- and high-impedance end-fed antennas. Because it also reduces harmonics by as much as 20 dB, using it properly will endear you to the XYL or OM—and to your neighbors. 73

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