A 100-kHz-30-MHz ACTIVE ANTENNA

Give your ham rig or DX station the pull it needs to catch the communications that you most want to hear!

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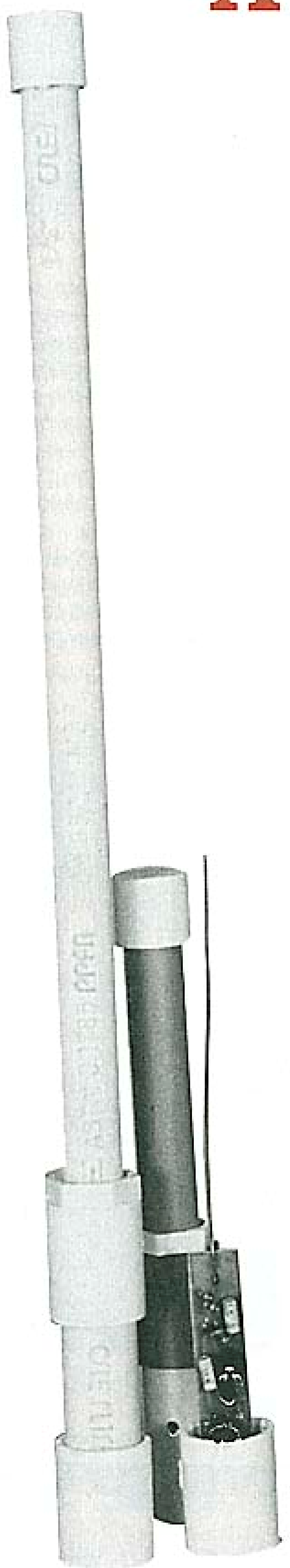


If you're an SWL or AM radio DX fan living in or near a large city, you've no doubt been plagued by one or more of the common antenna maladies. For example, no outside antennas are allowed in your community, or you live near an electric plant where high RF noise levels abound. Perhaps you simply have no room in your yard for an outside antenna. Other problems include theft and vandalism; esthetics and unsightly appearances; restrictive covenants; legal liability (kids, pets, *etc.*); fear of lightning strikes; and on and on, *ad nauseam*. And all ham radio fans know that even a good communications receiver is literally hobbled by a poor antenna.

In restricted use areas (high-rise apartment buildings, or dense-packed private homes) the antenna (usually a length of wire) is strung around the room in a vain attempt to pluck signals from the air. But an indoor antenna, surrounded by RFI-infested AC wiring, is, unfortunately, a very poor substitute for a well-constructed long-wire antenna. Adding to the problem are light dimmers, computers, fluorescent lighting, TV sets and video equipment, all of which can be real noisemakers. In addition, many newer electrical and electronic appliances and assorted gadgets are microprocessor controlled, which generates lots of RFI. Not to mention that with the frames of modern buildings comprised of various types of metals, it's like living inside a shielded can with RFI generators going full blast.

If you've encountered any of the drawbacks usually associated with the ham or SWLing hobby, then just maybe this article will be of interest to you. Presented here is a reasonable solution to most long-wire problems—the *100-kHz-30-MHz Active Antenna.*

Circuit Operation. A schematic diagram of the 100-kHz–30-MHz Active Antenna is shown in Fig. 1. The incoming signal is picked up by the antenna wire, and coupled via C1 to the gate of Q1 (an MFP102 FET, configured as a source follower). Capacitor C1 has a very high impedance to stray 60 Hz and 120

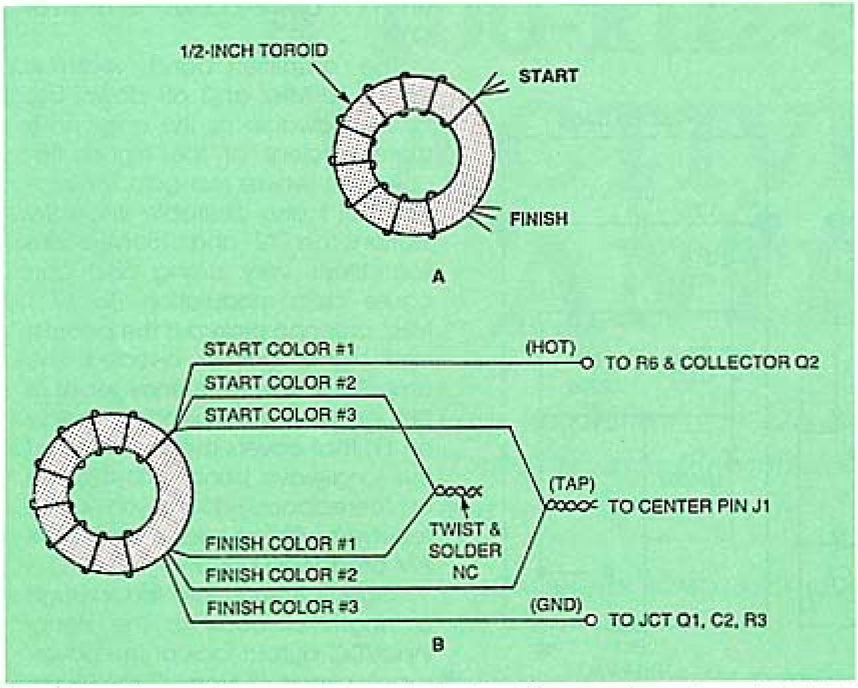


Fig. 3. Transformer T1 was wound on a $^1/_2$-inch toroid core, using color-coded 3-×-32 trifilar wire. Wind 20 inches of the trifilar wire on the toroid core, as shown in A, leaving about 1-$^1/_2$ inches of wire at each end of the winding. After separating the leftover wire at each end of the winding, strip, twist, and solder them as shown in B, and mark the joints and remaining ends accordingly.

$^3/_4$-inches. A full-size template of that printed-circuit pattern is shown in Fig. 2. Once you've etched your board, it's time to turn your attention to the transformer (T1), a hand-wound unit whose construction details are shown in Fig. 3.

Transformer T1 was wound on a $^1/_2$-inch toroid core, using 3 × 32 trifilar wire (three strands of 32 gauge wire that will be wound as a single unit). The trifilar wire should be color coded. If you cannot find color coded trifilar wire, don't despair, you can always color code individual wires by painting what you have on hand. Otherwise, you can use an ohmmeter to perform continuity tests to determine which wire is which, and then mark both ends of the wires accordingly. In any event, start by winding 20 inches of the trifilar wire on the toroid core, as shown in Fig. 3A, leaving about an inch and a half at each end of the winding. Separate the individual wires as illustrated, and then strip, twist, and solder them as shown in Fig. 3B; e.g., one end of color 1 is connected to one end of color 2, and other end of color 2 is connected to one end of color 3. Note that the connection between color 2 and color 3 forms the tap of the transformer, whereas there is no connection (NC) to the color 1/color 2 junction. Mark those connections accordingly.

Connect the finished transformer to the printed-circuit as shown in the parts-placement diagram (Fig. 4), and then install the rest of the preamp components in the positions indicated. Because Q1, Q2, T1 (as well as the wire used to wind the transformer), and NE1 are critical to proper circuit operation, no substitutions or modifications to those components are permissible. Make sure T1 is properly connected, and that Q1, Q2, C1, and C3 are installed with the proper orientation. Note: Although NE1 appears to be mounted to the component side of the board in Fig. 4, in the authors' prototype, it is actually soldered to the copper side of the board. Install a flange-type F-connector (which is used to mount the board to its enclosure, as well as connect the circuit to its power source) to the board where indicated, and then solder the antenna wire to the opposite end of the board.

The antenna pickup is little more than a length of #18 or #20 bare steel wire, but any similar diameter copper wire should suffice. The wire was soldered in line with and directly to the end of the board. The length of the pick-up wire is pretty much up to the builder; but a pick-up of from 16 to 24 inches is a good starting point for most applications. In severe cases, however, (if you live close to a transmitter) the pickup wire can be shortened as needed, but be warned that too short a pick-up wire (less than 12 inches) may reduce weak signal performance. A longer pick-up wire, up to 4 feet, can be used in weak signal areas. Pick-ups longer than 4 feet will not improve performance, and may lead to excessive signal input, resulting in spurious signal generation. Therefore, longer pick-ups are not recommended. If excessive interference and/or noise is heard with R5 at minimum and a shorter antenna, try relocating the antenna to a quieter location.

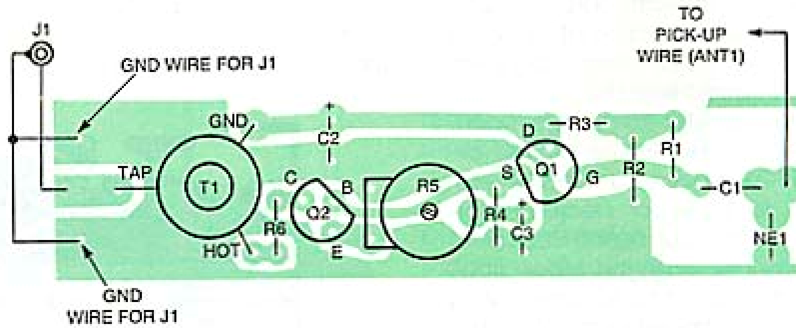


Fig. 4. Once you've etched your board and prepared the transformer, assemble the preamp board guided by this parts-placement diagram. When installing the components, be sure to connect the transformer as shown, and also see that the polarized components are properly oriented. Note that although NE1 appears to be mounted to the component side of the board, it is actually soldered to the copper side.

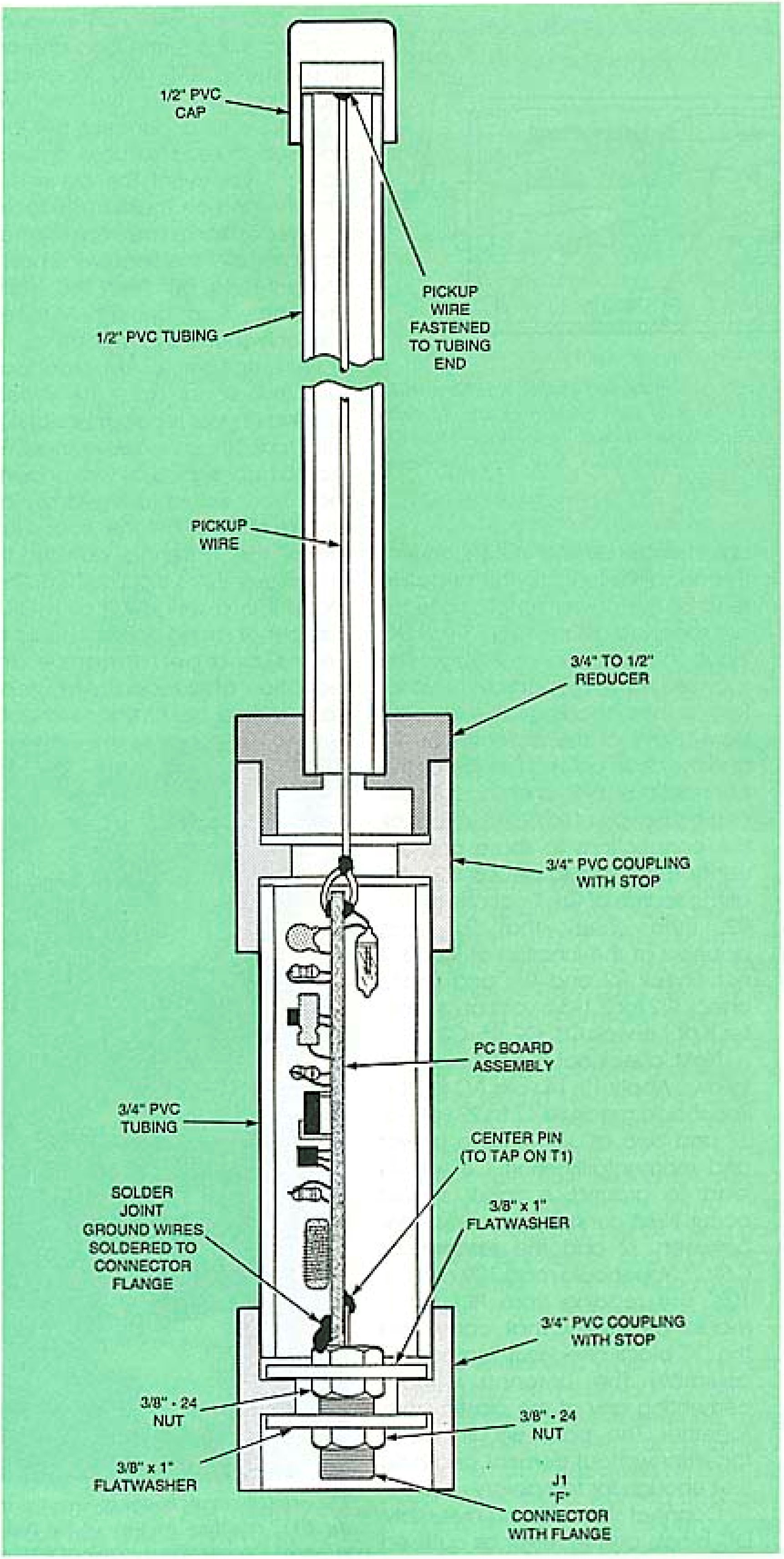


Fig. 5. The completed preamp board, along with its antenna wire is housed in a length of plastic PVC pipe. The board is first mounted into a 3/4-inch (ID) PVC coupling with stops using a pair of 3/8- × 1-inch flat washers and mounting hardware. See text for complete construction details.

Once the board is completed, put the circuit to the side and prepare the plastic PVC pipe that will house the preamp. The board is mounted into a 3/4-inch (ID) PVC coupling with stops using a pair of 3/8×1-inch flat washers, and mounting hardware. The coupling acts as a water shield for F connector J1. Note: Use gray or white PVC fittings. Black fittings may be ABS type and possibly the carbon pigment used could cause RF losses. Do not use metallic fittings. Figure 5 shows details of the preamp assembly and its PVC housing. First a nut is threaded onto the F connect to serve as a back stop. Then the washers are positioned one on each side of the coupling stop, and the F connector is threaded though the washers and secured with a nut.

Cut a piece of 3/4-inch (OD) PVC pipe to an appropriate length to cover the board (see Fig. 5.). The open end of the pipe is outfitted with another 3/4-inch pipe coupling, the coupling mates with a reducer and the reducer mates with a length of 1/2-inch pipe or conduit that holds the pickup antenna. A cap is placed at the end of the 1/2-inch PVC pipe that holds the far end of the antenna wire in place. The wire is folded over the pipe end and the cap forced over it. Do not use a screw as this will result in exposed metal and possible water leakage. Once that step is completed, check out all wiring and the component placement.

Now turn your attention to the DC Block. The DC block was hard-wired into a small metal box, as shown in Fig. 6. A good source of such enclosures are old video game switches or junked TV assemblies. You can also use a small metal project box. Do not use a nonmetallic enclosures, as RF shielding is necessary here. Wire the circuit together using Fig. 1 and Fig. 6 as a guide. The DC Block can be mounted in any convenient spot, as location is not critical. It would be best to choose a spot more than 2 feet from AC wiring to minimize the chance of noise pickup.

Checkout Procedure. After all wiring has been checked out and found to be OK, apply power to J1.

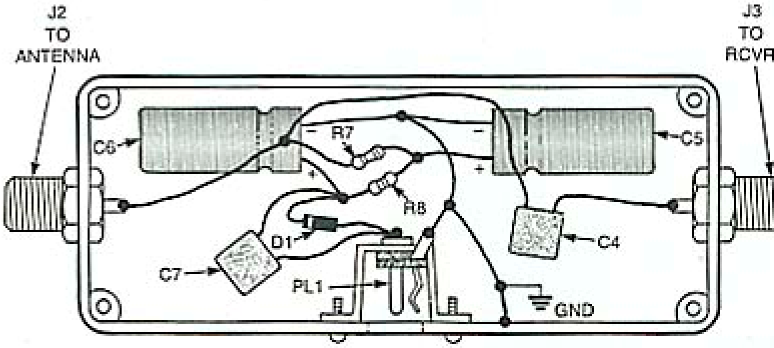


Fig. 6. The DC block, which serves as the preamp section's power supply, was hard-wired into a small die-cast metal enclosure. A good source of such enclosures are old video game switches or junked TV assemblies. You can also use a small metal project box. Do not use a nonmetallic enclosures, as RF shielding is necessary here. Wire the circuit together, using Fig. 1 and this illustration as a guide.

For the checkout procedure, use a positive 13-volt DC source with the negative lead connected to the preamp's ground plane. Set R5 to the default position as follows:

If you live in a city, set R5 at minimum gain (fully CCW). Also use that setting for the less expensive solid state receivers that may be susceptible to overload and spurious responses, as this antenna can deliver a lot of signal. Amplifier linearity will also be best at lower gain settings.

If you live in the country far away from strong AM signals, set R5 about halfway to two thirds CW from minimum.

Next, check for the following voltages using a DVM or VOM. Connect the negative lead to the negative lead of the power supply. Voltages are specified assuming a 13-volt DC input. This can vary ± 20%, so you may see some proportionate variations in these readings: There should be 13 volts at the collector of Q2 and the drain of Q1, if not check the connections to T1 and C2; 2.3 volts at the junction of R2/R3, if not check the connections to those components; there should be 2.8–4.2 volts at the source of Q1, if not check Q1, R2; then check that 2.3 volts appears at the junction of R2/R3, if not check R2 and R3; and finally, check Q2 for 2.1–3.5 volts at its emitter, if not check Q1, Q2, R5, C3.

Next, check out the DC block as follows: Apply 12–14 volts AC to PL1. You should measure 17 to 22 volts at J2 and zero at J3. Remove power and momentarily short C6 with a lead to ground. A spark should occur. Next connect an ohmmeter between J2 and the junction of C6/C7. You should read 129 ohms ± 10%. The reading from PL1 to J3 should be infinity. That completes the DC block checkout. Temporarily assemble the antenna without cementing any of the plastic parts together. The parts will fit snugly together without cement and hold well enough for temporary use.

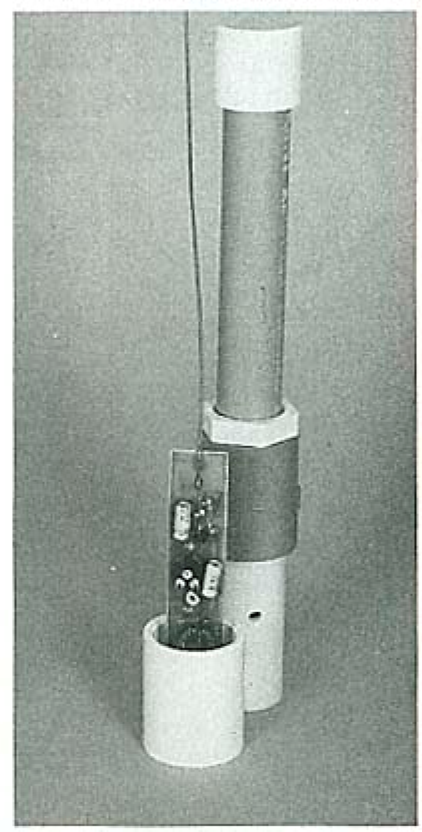
Connect the antenna assembly, DC block, and receiver as outlined in Fig. 7, and try out the antenna. For best results, your receiver should have a coaxial cable antenna connector. If the receiver has a whip or other built-in antenna, disconnect it. If a ferrite loop antenna is used for AM and long-wave reception (as is often the case), you may have to disconnect the loop and substitute a suitable antenna coil(s) if you want the benefits of this antenna on those frequencies. If SW reception is your main interest, you can use the receivers' built-in AM antenna, but then the active antenna will not benefit AM reception, only shortwave reception.

Set receiver to AM broadcast. Tune in a signal. Note the S-meter reading (if your receiver has one). If not, tune in a weak signal. You should hear signals as well or better than you would using a 20-foot length of wire on the floor. Next, place the antenna outside the building, or if this is difficult, you can place it in a window. If all is OK, a number of strong signals should be heard, and performance and reception of standard AM broadcasts should be similar to a good

CAUTION!!!

Use care when connecting this or any other antenna to certain older tube-type SW receivers that may use a hot chassis (AC/DC types), as a shock hazard may exist with these receivers. The S38D used as one of our test sets is this type. Check your receiver documentation to determine what it is. If in doubt, either consult a qualified technician or do not use this receiver with this antenna. Do not install this or any antenna or associated lead-ins near, over or under any power lines; or where there is a possibility of accidental contact with power lines. Performance will suffer, and you could be electrocuted.

Note that this antenna is for receiving only. Active antennas such as this are not designed for transmitting. Attempting to transmit with this antenna will destroy the preamplifier and may also damage the transmitter.



The printed circuit board is mounted into the PVC coupling by way of the board-mounted F connector, a couple of washers, and hardware. This holds the board rigidly in an upright position (as shown here), so that the unit's PVC tube housing can easily be slipped into position over it.

PARTS LIST FOR THE 100-kHz-30-MHz ACTIVE ANTENNA

SEMICONDUCTORS

Q1— MPF102 N-channel JFET
Q2— MPS3866 NPN silicon transistor
D1—1N4007 1-amp, 1000-PIV, rectifier diode

RESISTORS

(All resistors are 1/4-watt, 5% units, unless otherwise noted.)
R1—10-megohm
R2—10,000-ohm
R3—47,000-ohm
R4—1000-ohm
R5—100-ohm potentiometer
R6—22-ohm
R7—82-ohm
R8—47-ohm

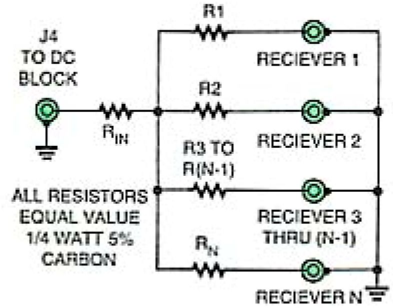
CAPACITOR

C1—4.7- pF, ceramic disc
C2, C3—1-µF, 50-WVDC, electrolytic
C4—0.047-µF, 50-WVDC, Mylar
C5, C6—2200-µF, 25-WVDC, electrolytic
C7—0.1-µF, 50-WVDC, Mylar

ADDITIONAL PARTS AND MATERIALS

NE1— Small neon lamp (100-volt breakdown, CM1 type)
T1—Ferrite toroid core (P/N 768T188-3E2A)
J1–J3—Chassis mount F connector with flange
PL1—2.1 or 2.5 mm connector.
Printed-circuit materials, 3 × 32 trifilar wire, 12–14-volt AC, 100 mA wall transformer, metal enclosure, 16- to 48-inch length of 1/2-inch PVC pipe, 3- to 41-inch length of 3/4-inch PVC pipe, 3/4-inch PVC couplings, 3/4- to 1/2-inch PVC reducer bushing, 3/8-× 1-inch washer, 3/8-24 Hex nuts, PVC cement, wire solder hardware, *etc.*

Note: The following items are available from North Country Radio, PO Box 53, Wykagyl Station, New Rochelle, NY 10804: A complete kit of parts (minus the wall transformer) for the 100-kHz–30-MHz Active Antenna for $19.50 plus $4.50 S/H. The plastic parts (pipe and fittings) are not included in the kit to reduce shipping costs. A suitable wall transformer is available for USD $9.50 plus $1.00 S/H. NY residents add 8.25% sales tax. A catalog of kits for amateur radio projects, ATV transmitters, downconverters, receiver and video accessory kits, video and surveillance cameras and lenses is available for $2 (refundable with first order) plus SASE with $0.75 postage and handling from the above address.



NUMBER OF RECIEVERS	50Ω CABLE	75Ω CABLE
2	16Ω	24Ω
3	24Ω	36Ω
4	30Ω	43 OR 47Ω
5	33Ω	51Ω
N	$50\left(\frac{N-1}{N+1}\right)\Omega$	$75\left(\frac{N-1}{N+1}\right)\Omega$

RESISTOR VALUES
(NEAREST 5% TOLERANCE)

Fig. 8. If you are one of the many SWLers who own more than one receiver, perhaps a signal splitter may be of use to you. The signal splitter can be built using a few jacks, a metal case, and a few resistors.

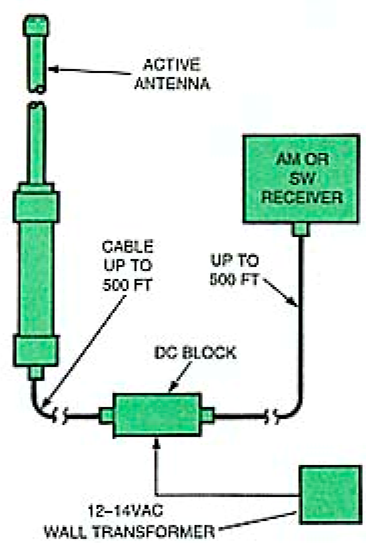


Fig. 7. Connecting the 100-kHz–30-MHz Active Antenna to your receiver is a simple task. As outlined here, you simply connect the antenna assembly to the DC block, and the DC block to your receiver. Coaxial cable runs of up to 500 feet can be placed between the antenna/preamp and the DC block or between the DC block and your receiver. Don't forget to plug a 12 to 14 volt AC wall transformer into PL1—after all, the preamp really could use the power.

AM auto radio. If not, check all wiring and the cables, and connections to T1. If reception is noisy try another location as indoor locations are usually noisy. Next, try the antenna on shortwave signals.

Adjust R5 for best performance. Use R5's default setting at first, and if the setting seems OK or doesn't seem to matter, then it is best to keep it. You may want to experiment with R5's setting for various reception conditions for a time before deciding. Use as low a gain setting as possible, and if any cross modulation or intermodulation is noted, adjust R5 to reduce gain.

Final Assembly. When you are satisfied that all is well, you can permanently assemble the antenna, using PVC plastic cement at all joints. If you've not yet decided on a setting for R5, or if you want to change it some time, you can drill an access hole in the 3/4-inch PVC pipe to allow a small screwdriver blade or alignment tool to get at it. A 1/8- or 3/16-inch hole will do. Be sure to seal it with silicone rubber or electricians putty before outdoor use as water could leak in and destroy the PC board. Such sealants are easily removed and replaced. The antenna can be mounted almost anywhere, but a location in the clear, well away from AC and telephone lines and buildings (30 to 50 feet, or more) is always the best. The small inconspicuous size of the antenna helps greatly in that regard.

You can also mount the antenna on a post, fence, railing, vent pipe, on the terrace, *etc.* You can use another length of 3/4-inch PVC pipe as a mounting support, inside of which the coax can be run. The antenna will fit snugly on the 3/4-inch PVC pipe, and no cementing is necessary. You can use a small self-tapping sheet metal screw to secure the antenna, if desired, but it is unnecessary in most cases. For ground mounting, the coax can be fed through a drilled hole in the support and buried underground for a completely hidden installation. Make sure J1 and coax connectors are at least 6 inches above ground—12 inches would be better to allow for snow and ice. If you are

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