ARRL Periodicals Archive – Search Results

A membership benefit of ARRL and the ARRL Technical Information Service

ARRL Members: You may print a copy for personal use. Any other use of the information requires permission (see Copyright/Reprint Notice below).

Need a higher quality reprint or scan? Some of the scans contained within the periodical archive were produced with older imaging technology. If you require a higher quality reprint or scan, please contact the ARRL Technical Information Service for assistance. Photocopies are $3 for ARRL members, $5 for nonmembers. For members, TIS can send the photocopies immediately and include an invoice. Nonmembers must prepay. Details are available at www.arrl.org/tis or email photocopy@arrl.org.

QST on CD-ROM: Annual CD-ROMs are available for recent publication years. For details and ordering information, visit www.arrl.org/qst.

Non-Members: Get access to the ARRL Periodicals Archive when you join ARRL today at www.arrl.org/join. For a complete list of membership benefits, visit www.arrl.org/benefits.

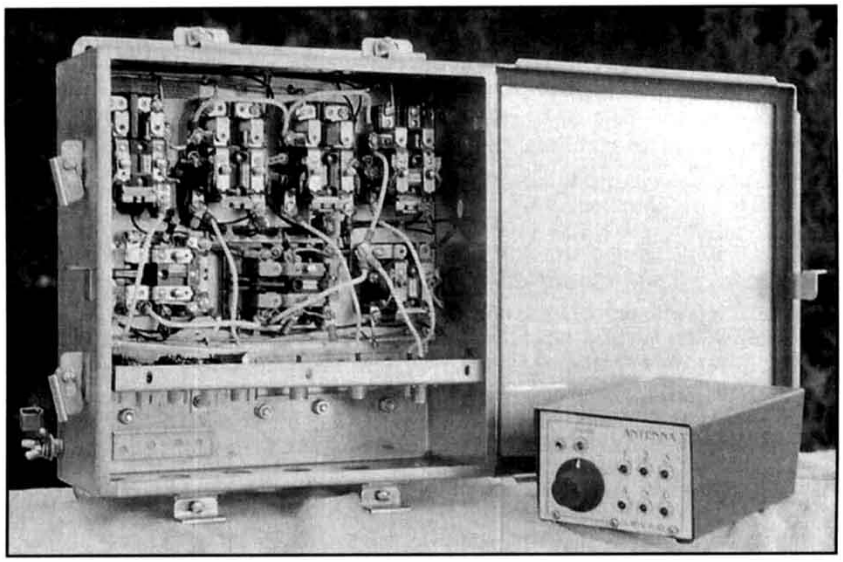
Copyright/Reprint Notice

QST Issue: Aug 1997
Title: A Remote Antenna Selector Switch
Author: Herbert M. Rosenthal, W5AN

Click Here to Report a Problem with this File

By Herbert M. Rosenthal, W5AN

A Remote Antenna Selector Switch



Build this switching system to feed multiple antennas through a single coax line and improve station safety.

Here in the Southwest, ungrounded antennas can develop a substantial static charge from the movement of hot, dry air, even with *no* lightning in the area. This static charge can become high enough to damage a transceiver. Grounding the antenna system when not in use prevents static buildup and helps protect your station.

The antenna selector described here requires only a single coax cable and one shielded control cable to access six antennas, which eliminates four cables.

The control box operates relays mounted in a weatherproof box positioned outside the shack. All unselected antennas are grounded; when the control-box power is switched off, *all* antennas *and* the feed line are grounded—*outside* the shack.

The benefits of this switching system are: prevention of static buildup on antennas, reduced cable costs and enhanced lightning protection (against reasonably distant strikes). For more information about lightning and shack safety, see the sidebar about Safety Concerns.

If you don't have six antennas, adapt this system to the number of antennas you use, adding a spare relay or two for the future. Hams with only one antenna can use single external, weatherproof relays to ground their systems.

Parts

I was fortunate to find the relays and a new, very expensive stainless-steel cabinet at a good price in a local surplus store. The parts list shows a less-expensive NEMA 3R (weatherproof) cabinet and relays, with their sources. The peace of mind you gain by automatically grounding your antenna system whenever the control-box power is off justifies the cost of this system.

Relay Cabinet

Weatherproofing

A door gasket, silicon caulk at all holes and electrician's strain-relief connectors with O-ring seals protect the relay cabinet against weather and insects. If spiders can lay eggs in my triband beam traps up thirty feet (it really happened), it is a challenge to keep them and moisture out of the relay cabinet just five feet off the ground.

Mechanical

To minimize the number of holes in the cabinet, the seven relays mount on a piece of $^1/_8$ inch thick aluminum cut from an old seven-inch rack panel. This plate mounts inside the cabinet to five $^1/_4$ inch bolts—one at each corner and one near the center. For ease of mounting, the bolt heads are outside the cabinet. A fiber washer, lock washer and nut inside the cabinet make a good waterproof seal.

You can wire the relay panel on a workbench, then secure it onto the mounting bolts to complete the wiring. Split washers and nuts secure the relay panel to the bolts. Each control wire from the diode and capacitor terminal strips to the relay is about seven inches long and bundled into a cable. To replace a relay, just unscrew the relay end of the coax connector leads and loosen the ground lug.

There are seven $^7/_8$ inch diameter holes on the bottom of the cabinet aligned with the coax connectors inside. I made the holes with an electrician's $^1/_2$ inch-conduit punch. A PL-259 will just pass through this hole and a $^1/_2$ inch-conduit nut. The control cable mounts through a $^3/_4$ inch conduit hole ($1^1/_8$ inch diameter), just large enough to pass the two control plugs and cable. This hole requires a $^3/_4$ to-$^1/_2$ PVC pipe adapter to fit the strain-relief connector.

Metal hole cutters—the ones that look like a rotary hacksaw blade—can make the conduit holes, too. Don't attempt to make the holes with a hand drill and an *adjustable* hole cutter. It's much too dangerous! If you don't have the punches, seek help from an electrician.

The SO-239s, P1 and J2 mount on a second panel inside the cabinet. All PL-259s, J1 and P2 connect to them *inside* the cabinet. All cables enter the cabinet from the bottom, through strain-relief connectors. See Figure 2.

Conduit hole-reducer washers (another electrician's item) under the conduit nuts compress hardware-store O-ring washers to make a good seal. Place the strain-relief connectors on the RG-8 *before* installing the PL-259. Place the strain-relief connectors *and* the pipe-thread adapter on the control cable *before* installing J1 and P2, the two six-pin connectors.

Use the strain-relief connectors with care; they are intended to secure metal-jacketed

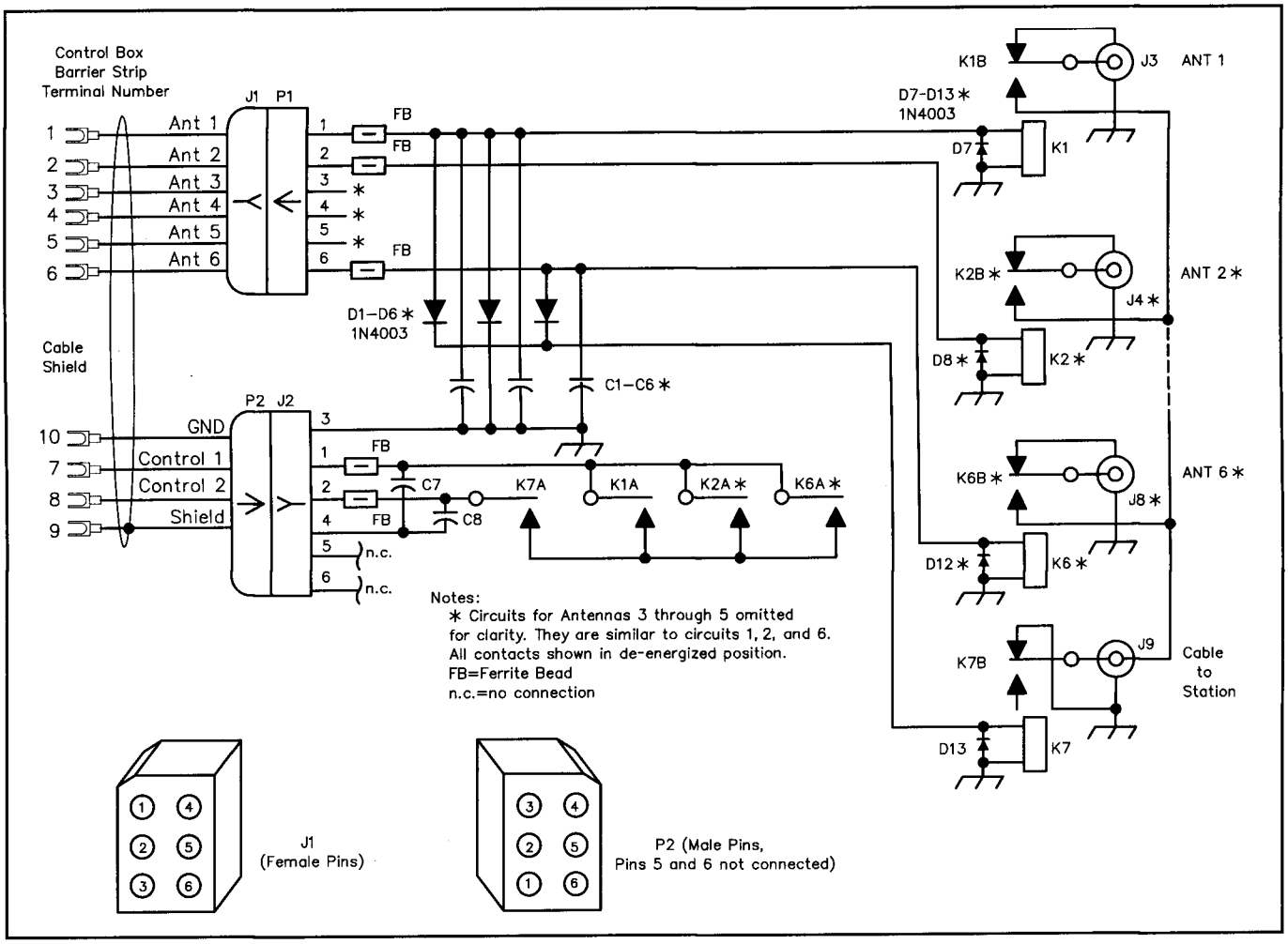


Figure 1—Relay box schematic. See Table 1 for a parts list. Equivalent parts may be substituted for those shown.

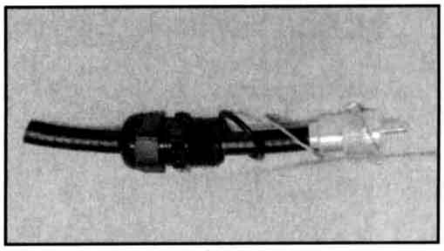
Table 1
Parts List and Sources

Supplier's part numbers are in parentheses: Mouser Electronics, 958 N Main St, Mansfield, TX 76063; tel 817-483-4422; fax 817-483-0931; e-mail **sales@mouser.com; http://www.mouser.com**. Newark Electronics, 4801 N Ravenswood Ave, Chicago, IL 60640-4496; tel 800-463-9275, 312-784-5100; **http://www.newark.com/Newark.** RS numbers are Radio Shack.

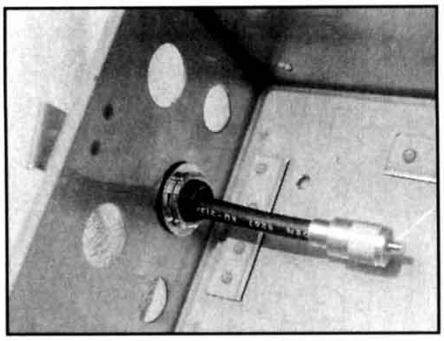
C1-C6, C11-C16—1000 pF, 500 V ceramic disc (RS 276-126)
C7-C10—0.01 µF, 500 V ceramic disc (RS 272-131)
C17—2200 µF, 50 V, electrolytic (RS 278-1048)
DS1—Green LED in holder (RS 276-069)
DS2-DS7—Red LED in holder (RS 276-068)
F1—5×20 mm fuse, 0.5 A fast blow (RS 270-1047)
FB—ferrite bead, 16 req'd (up to 40 MHz, Mouser 542-FB73-226)
J1, J2—6-pin connector (female), 9 A contacts (RS 274-236)
J3-J9—Coaxial connector, builder's choice
J10, J11—Panel-mount phono jack (RS 274-346)
K1-K7—24 V dc, 30 A relays, Potter & Brumfield PRD11DYO/24DC (Newark 33F1546; Dayton 3x749 DPDT 30 A)
P1, P2—6-pin connector (male), 9 A contacts (RS 274-226)
R1, R2—2700 Ω, 1 W (Mouser 262-2.7 k)
R3—150 Ω, 5 W wire wound (Mouser 588-VL5-150)
S1—SPST 1/4-inch toggle switch (RS 275-634)
S2—2P6T rotary switch, nonshorting (RS 275-1386)
T1—25 V c. t., 2 A transformer (RS 273-1512)

Miscellaneous:

Ac power cord (RS 278-1258)
Barrier terminal strip 10 #6 screws (Mouser 506-6PCV-10)
Control box (RS 270-253)
5×20 mm fuse holder (RS 270-362)
6 terminal strips (solder, RS 274-688)
7 electrician's 1/2 inch cable straight strain-relief connectors, such as Hubbell HJ1060G or Grainger 5D531
9×#24 shielded control cable with PVC jacket (Newark Belden 9539 or equiv.)
Hardware: 1/2 and 3/4 inch conduit nuts, 3/4-to-1/2 PVC NPT thread reducer, 7/8 and 1 1/8 inch O-rings, 3/4 to 1/2 inch hole washers; duct tape, silicon caulk, 7×11×1/8 inch-thick aluminum plate, 1/4 inch stainless-steel bolts, nuts and lock washers, 1/4-inch fiber washers (Newark 95N7998), stick-on feet, #6 hardware, 2 #10×1/4 inch copper wire lugs, #4 AWG bare copper wire, ground-pipe clamp, #12 AWG solid copper wire, #12 TFFN (stranded) white, #16 TFFN (stranded) black, **U** bolts, etc.
Power-cord grommet (RS 64-3025)
Relay Cabinet 12×12×6 inches, the prototype is a Hoffman Model 4X SS (Newark 96F4702, very expensive); alternate: Wiegmann NEMA 3R A1212CH RSC10126 with screw cover.
14 wire terminals #8, #12-10 AWG, yellow, (Mouser 571-32589)
14 wire terminals #8, #22-16 AWG, red, (Mouser 571-32053)
24 wire terminals #6, #22-18 AWG, red, (Mouser 571-34541)



(A)



(B)

Figure 2—A shows RG-8 with weather-seal hardware and PL-259 in place. B shows the cable and weather hardware installed in the relay box. Be sure to slip the weather hardware on the cable before installing the connector! This is also true for the control cable hardware and connectors. See text.

cable. Here we use them only to seal soft-jacket coax against water. Tighten the closure nuts *by hand*. If they're too tight they may distort the coax dielectric.

You can make an alternate waterproof seal for each cable with inexpensive conduit end fittings. Place the fitting onto the cable before the PL-259, install the plug and screw it to its mate. Then install the fitting at the box wall and stuff the space between the cable jacket and the fitting with electrician's putty. (This glop never hardens. It's easy to remove—and cheap).

Circuitry

Six 24 V dc DPDT relays (K1-K6) connect to six SO-239 connectors (Ant 1 through Ant 6), one connector for each antenna. When de-energized, the B poles of K1-K6 ground the antennas. All relay grounds are #12 AWG solid copper wire that connects to a #12 bus. The ground bus connects to a 1/4 inch bolt that passes through the relay cabinet and holds the external copper ground lug.

The RF wiring between the coax connectors and the B relay contacts is #12 AWG stranded copper wire. Crimp and solder each wire into a fork terminal at the relay terminals. Dress the RF wiring high in the cabinet, with maximum spacing from the relays and the control wiring, as shown in the lead photo. This minimizes coupling between antennas. A solder lug at one mounting screw of each SO-239 connects via a #12 bus to the 1/4 inch ground bolt.

D1 through D6 connect the high side of each antenna relay coil to K7, so that *any* signal to them activates K7 as well. This opens contact K7B and ungrounds the station bus. Bypass capacitors (C1 through C6) and reverse-biased diodes (D7 through D13) at K1-K6 eliminate switching noise and shunt the back-EMF generated when a relay is de-energized. These components mount on terminal strips next to the rear of P1 and J2. A small bracket shields these components from the RF wiring.

Signal leads connect to P1 and J2 much as shown in the inset of Figure 3. Solder a suitable length of #16 AWG stranded copper wire of one leg of a 1000 pF bypass capacitor near the capacitor body. Place a ferrite bead over the same leg. Trim the lead to fit an appropriate pin (male or female), then crimp the pin onto the wire and solder the connection. Finally, insert the pin into its connector hole (see Figure 1) and push until it locks in place. I used two six-pin connectors so the connectors would fit through one entrance hole in the cabinet, one at a time. A single 12-pin connector would be too large. P1 uses male pins and J2 uses female pins to prevent transposing the two connectors.

The normally open A contacts of K1 through K6 parallel connect to each other and then the group series connects to the normally open A contact of K7. The closure of any of the first six relays *and* K7 form a closed circuit. This is the control circuit that may serve as a ready-to-transmit signal for an amplifier or transceiver.

All the relay-coil and A-pole leads are #16 AWG stranded copper wire. Dress these leads low in the cabinet, against the mounting plate and bundle them with tie wraps.

Safety Concerns

Lightning

It is extremely difficult to prevent damage from direct or near-direct lightning discharges. Strikes may carry hundreds of thousands of amperes that produce kilovolts across even tiny conductor and ground impedances. Lightning leaps thousands of feet to reach the ground; it might easily jump tens of feet to reach your grounded equipment. The relay-contact gaps and conductors in this project cannot protect your station from such forces. If your station receives frequent, strong nearby or direct strikes, consult a lightning protection professional for adequate protection.

This system does help protect your station from relatively minor voltages (several hundreds of volts) induced by close lightning strikes. It should *not* be your only protection against lightning.

Important Resources

Many important aspects of proper antenna switching and grounding systems are discussed in *The ARRL Handbook*, *The Antenna Book* and in a recent ARRL "Lab Notes" column in *QST*.* I encourage you to read these references. You will gain insight into a rather complex, yet manageable part of your station design. Such items as coaxial surge arrestors and entrance panels are of primary importance. No one piece of equipment represents a total solution.

All aspects of your ground and lightning protection installation *must* conform to local building codes, which often defer to the *National Electrical Code*. Consult local building officials while planning and building your system. Electrical code requirements protect you and your family against fire and electrocution. Noncode electrical work may jeopardize your safety and affect your home insurance coverage.

A Big Switch

You've probably seen the ARRL "Switch to Safety" slogan, complete with an electric disconnect box (handle in the *off* position), published in *QST* for the past century (or so it seems).† That's good advice. Don't rely on individual equipment switches alone.

A single, well labeled switch should kill the power to *all* of your station equipment at once.†† A "big switch" lets anyone nearby can easily kill the power should you, or a visitor, become trapped across the ac line. Throw the switch as you leave the shack, and the antenna switch in this article will ground your antenna system too!

*Paul Danzer, N1II, *The 1997 ARRL Handbook for Radio Amateurs* (Newington: ARRL, 1996), see the Safety chapter. The 1997 edition (Order No. 1743) is $38 plus $6 shipping/handling. ARRL publications are available from your local ARRL dealer or directly from ARRL. Mail orders to Pub Sales Dept, ARRL, 225 Main St, Newington, CT 06111-1494. You can call us toll-free at tel 888-277-5289; fax your order to 860-594-0303; or send e-mail to **pubsales@arrl.org**. Check out the full ARRL publications line on the World Wide Web at **http://www.arrl.org/catalog**.

R. Dean Straw, N6BV, Ed., *The ARRL Antenna Book*, 18th edition (1997, Order No. 6133; $30 plus $5 shipping and handling).

The *QST* "Lab Notes," for October and December 1994 comprise the TIS information package "Lightning Protection," available from the ARRL Technical Department Secretary (ARRL members $2, nonmembers $4, postpaid). The text of Lightning Protection is available at no charge from the ARRL "Hiram" BBS (tel 860-594-0306), or the ARRL Internet ftp site: **ftp://oak.oakland.edu/pub3/hamradio/arrl/infoserv/tech** or one of the mirror sites listed on the ARRL Web page **http://www.arrl.org**. In all cases, look for the file lightnin.txt.

†The 'Switch to Safety' logo first appeared in the August 1939 *QST* and yet remains. It began as part of a general safety campaign answering several members' deaths by electrocution (one or two every month, or so), including *QST* Editor Ross Hull (see "It Seems to Us," *QST*, Nov 1938, p 9).—*Ed.*

††Our equipment is only *safe* from lightning when completely disconnected from the power line, antenna and ground connections.—*Ed.*

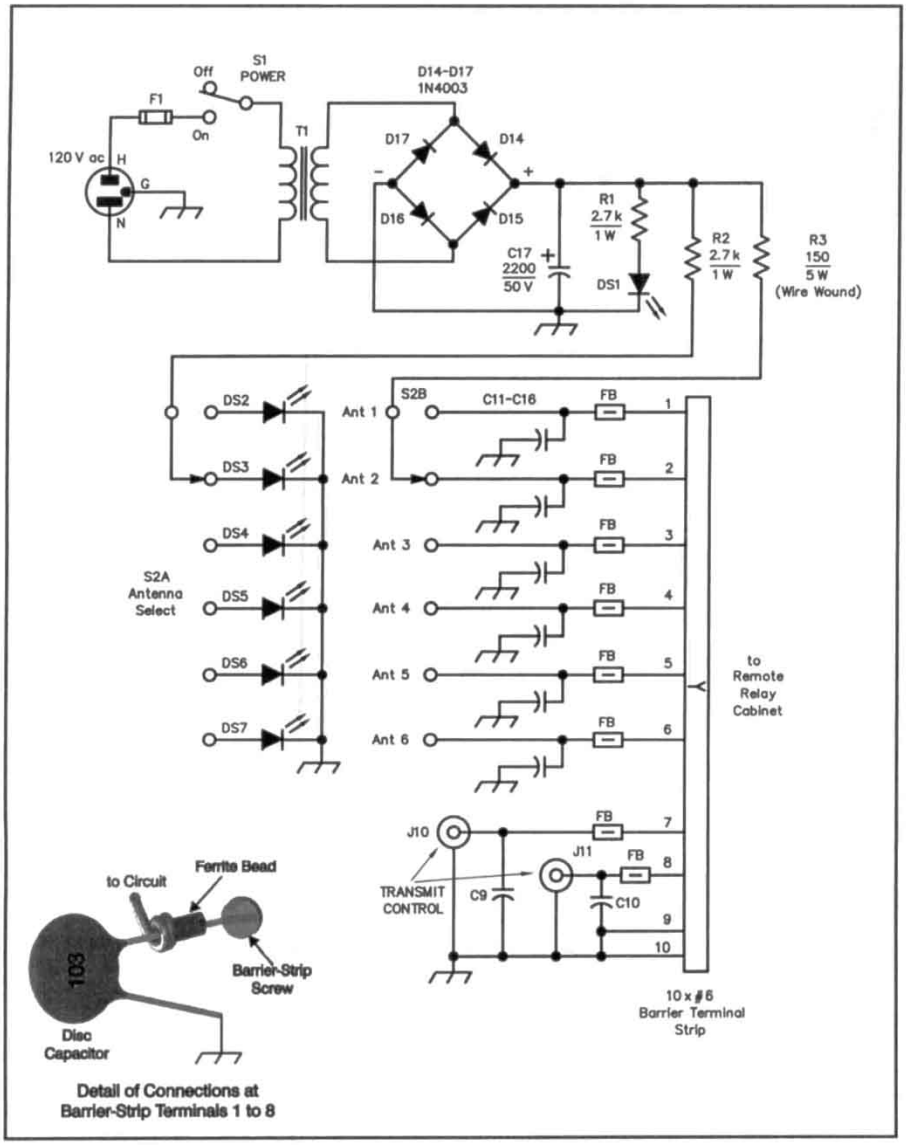


Figure 3—Control box schematic. See Table 1 for a parts list. Equivalent parts may be substituted for those shown.

Control Box

Mechanical

There's little special about the control box mechanics. Several terminal strips hold the components for point-to-point wiring. I made the panel graphic on my Macintosh using a drawing program. I printed it on ordinary paper, covered it with clear adhesive shelf film and glued it to the panel using UHU stick cement.

Circuitry

Refer to Figure 3. A full-wave bridge power supply provides filtered 35 V dc. This voltage is higher than necessary for the 24 V relays, but the low cost and availability of the transformer makes this a sensible choice. The 150 Ω resistor drops the voltage to about 20 V, enough to operate the relays with up to 100 feet of control cable.

A two-pole, six-position rotary switch selects one of the six relay-control lines, and activates one of six LEDs used to indicate the selected antenna. Two phono jacks on the rear panel provide connection to the transmit control circuit.

The control-cable connections attach to a 10-position, #6-screw terminal strip on the control-box rear panel. I chose this connector so the shack-end control-cable connectors (fork terminals) would fit through a 1½ inch conduit at the shack, along with other cables (VHF) and the single coax from the relay cabinet. Bypass capacitors and ferrite beads filter the control cable leads as do their counterparts in the relay cabinet.

The Control Cable

The control cable has nine #24 AWG stranded copper conductors inside a shield and a PVC jacket. The relay-cabinet end has two six-pin connectors, J1 and P2, and the shack end uses crimped and soldered #6 fork terminals.

At the Tower

U bolts secure the relay cabinet to my tower. The tower is grounded beneath its concrete base with two 10 foot copper rods, and to a nearby 10 foot copper ground rod. A #4 AWG solid-copper wire connects a heavy lug on the relay cabinet to about 30 feet of buried copper pipe, an abandoned water line that is separate from the main water system. Don't simply connect the ground lug to a water pipe and forget it. Contact your local officials and install a safe and legal ground system.

Performance

The choice of Potter & Brumfield PRD-series relays (or equivalent, with large, widely spaced contacts) and proper placement of the relays, connectors and wiring has resulted in a system with little or no mismatch, cross coupling between antennas or power loss. I tested the prototype with my Yaesu FT-840, a Bird Thruline wattmeter, an MFJ Antenna Analyzer and an accurate 50 Ω load. The receiver is dead quiet when the control-box power is off—or when I select an unused antenna port.

This project may sound like a lot of work, and it is, but it's worth the effort to have your antennas and coax grounded when the station is not in use, you're a thousand miles away—and you forgot to unscrew the coax.

Herb Rosenthal, W5AN, was first licensed as W2PIV in 1946, while attending high school in Syracuse, New York. He also earned his First-Class Radiotelephone license and worked as an engineer at AM broadcast station WOLF while in high school. During two years of EE studies at the Syracuse University, Herb operated a 2½ W FM educational station, WAER, one of the first FM broadcast stations in the country. Herb's present callsign is his eighth; it's a vanity call sign treat to himself after 50 years of mostly CW operation, including time working pileups as HS1ADX while stationed in Bangkok during 1971-72.

Herb joined the Air Force in 1951 (Korean War), where he was commissioned and rated as a navigator. He spent 26 challenging years in uniform, with assignments in research and development, flying, communications, security, teaching navigation at the Air Force Academy and commands. He completed his BSEE at the University of Texas while in the Air Force. After retiring from the Air Force in 1976, Herb (as KL7AE and AL7G) worked for Chugach Electric, the major electric utility in Alaska. His duties included electronics, communications, SCADA and telephony. Now retired, Herb devotes his time to traveling with his spouse, enjoying his fourth Macintosh computer, homebrewing ham gear and occasional CW ragchews. You can reach Herb at 10508 Karen Ave. NE, Albuquerque, NM 87111; e-mail **herbrose@lobo.net**.

Photos by the author.