The BCC Beverage Box

Bavarian Contest Club Reveals Secret Invention

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When asked to write an article about the BCC Beverage Box, my first reaction was: "Should we really open up this secret invention to the public, which had given us such a nice low-band receiving advantage in past contest operations?" I asked around among members on the BCC mailing list and finally Rick, DJØIP, came up with the following statement which convinced me: "The technology of BCC is good, the people are too, and we need not fear competition. Let's, in good old fashioned ham spirit, share what we know, as well as a detailed explanation of the benefits. The ROI (Return On Investment) may be intangible now, but good deeds do get rewarded. Maybe someday, someone who benefited from our tip on technology may donate the needed money to launch the greatest expedition we have ever endeavored."

"Furthermore, this may help our American ham friends get over their 'NIH' syndrome. What's an NIH syndrome? 'Not Invented Here.' Those guys used to think that everything good simply had to be invented in the United States. In the meantime, they are slowly coming to grips with the fact that good technology can come from almost anywhere else. I confront this daily in my work as an industry analyst."

"While they are busy dissecting our technology of yesteryear, we will surely be developing new. After all, haven't we always been successful using our heads and having a team who quickly adopted the new concepts? The BCC is the fairest contest group in the world. And the friendliest. And, we're probably the only contest group in the whole world with our own beer: BCC beer. PROST!" I think he's right, so here we go.

Zero Generation

It all started out when I saw an article by ON4UN in VE3BMV's contest journal called *Radio Sporting*, circa 1985. There was a description of a Beverage array consisting of 12 Beverage antennas that were fed using only four coax lines. Three of the antennas came together at one switch box, which contained a 1:9 transformer and a simple circuit allowing the selection of one of the three antennas by either applying –12, 0, or +12 volts. The coax line was used both as a control line for selecting one of the three anten-

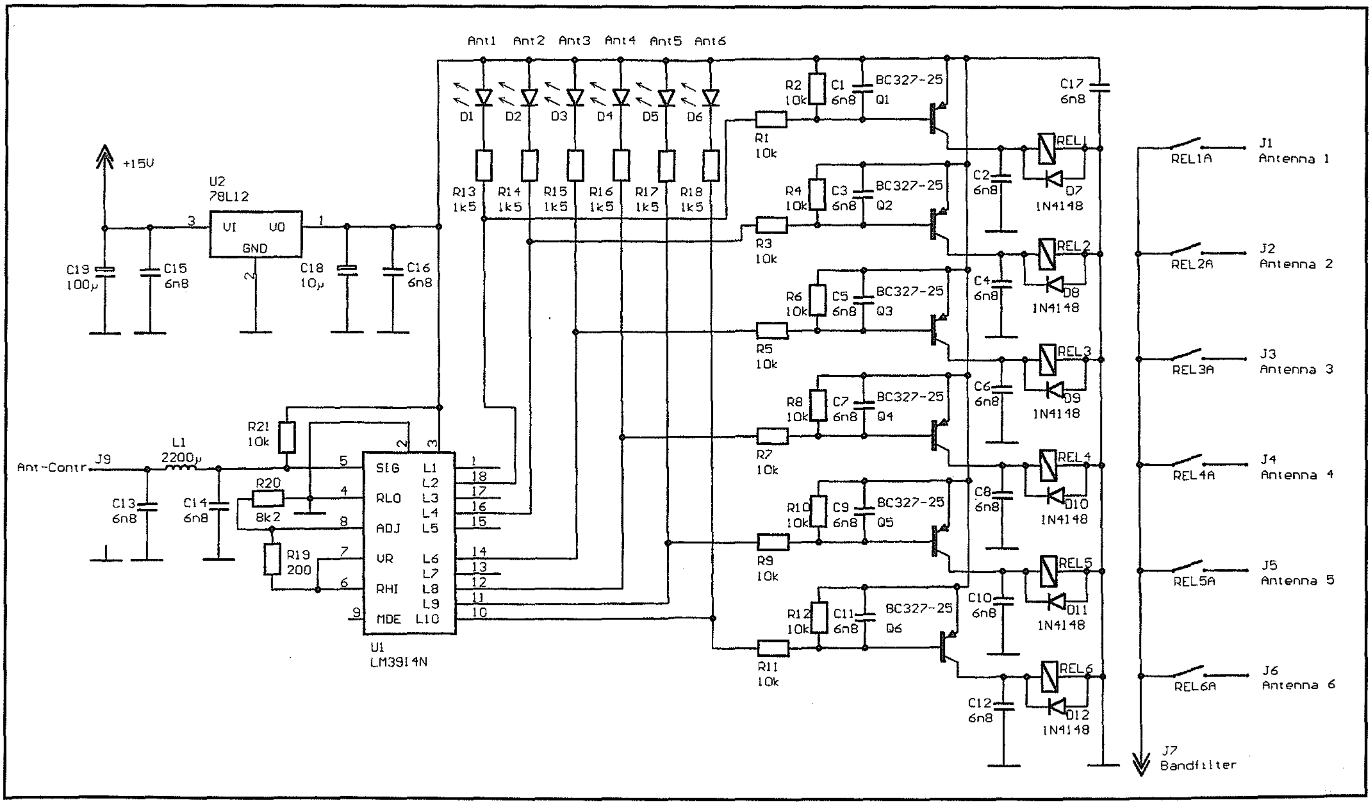

Figure 1. Circuit diagram of the relay box.

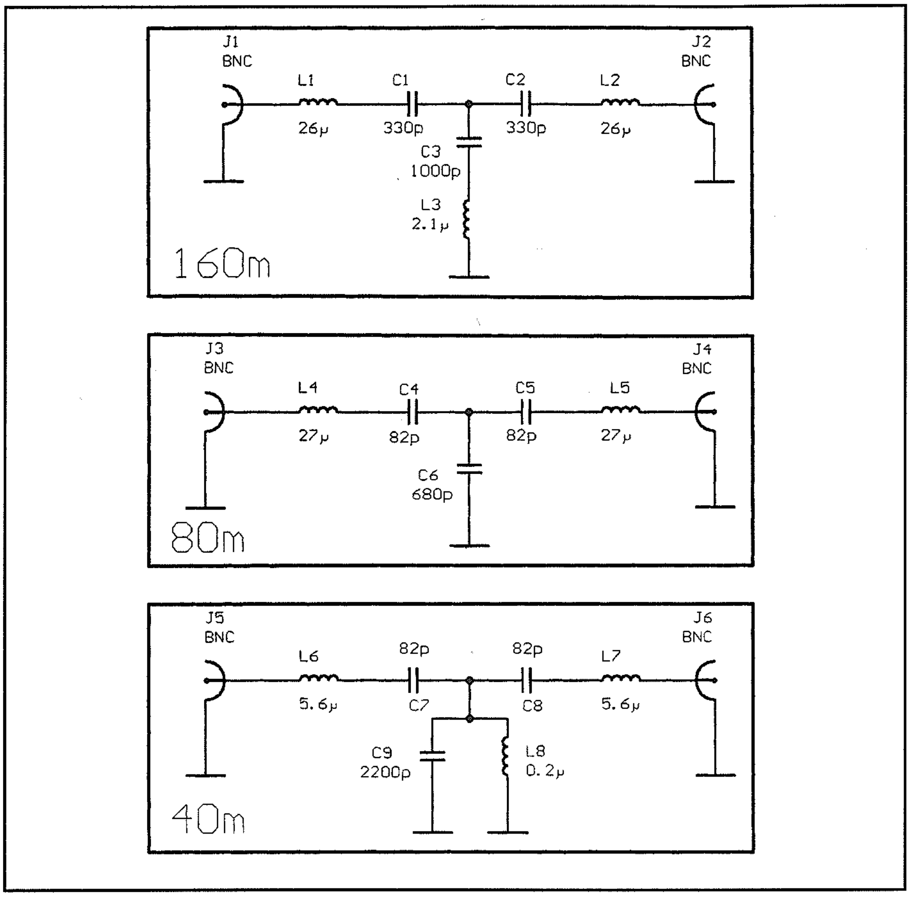

Figure 2. Circuit diagram of the split filter for 40, 80, and 160.

nas, and as a carrier for the received signals. I built one of these boxes, and it was first used at the LX9BV and HBØ/DL8OH operations in 1987. The advantage of this simple circuit was that you could get away with using only one single long coax run with your Beverage receiving system.

First Generation

In 1989, the BCC attempted to break OHØW's long-standing 1982 Multi-Multi European record. We needed a better receiving system for the low bands. Thomas, DL7AV, Wolfgang, DL5MAE, and I devised a box that we call the "first generation." Ten Beverage wires with lengths of 100 to 200 meters were put up in a star configuration with one central feedpoint. All of the wires were attached to a huge relay box that contained ten 9:1 transformers, 30 relays, and a split filter used for combining the selected signals into a single coax line. Each of the three bands (40, 80, and 160 meters) had its own set of 10 relays connected to the output side of the transformers.

We were able to reduce cable complexity to just two (long) cables: a 4-wire control cable and one single coax cable. The control lines carried control signals for each band, enabling the selection of any of the 10 antennas. The selection was accomplished using analog voltage levels in 3-volt intervals (i.e., 3 volts selects antenna #1, 6 volts antenna #2 and so on, up to 27 volts for antenna #10). The isolating effect of the split filter enabled each station to access any antenna, even at the same time other stations were accessing the same one, without interfering with the other stations. In the shack, a master control box held the power supply for the remote relay box. It applied 30 volts of DC to the output ports through a dropping resister. It, too, had a split filter that separated the combined signals into separate signals, feeding them to the individual output ports. The control boxes at each station had a DC/RF splitter circuit. The RF was fed to the receiver. The DC signal went to a 1 × 12 switch that selected the appropriate dropping resistor in the power supply box, and, the desired antenna.

Though it sounds complicated, it worked great! We had some trouble at LX7A (1989) because Radio Luxembourg (located just a few miles away) got into the control lines, causing relay chatter. DL7AV and DL5MAE debugged the box on site, enabling the expected performance. Our low-band results were phenomenal. We were very successful, setting both the EU Phone and CW record, which still stands today.

This receiving antenna system was used successfully again at the DAØBV multi-multi in both 1990 CQ WWDX contests, and is still in use today at our Siegenburg contest location. It combines multiple Beverage antennas into one big "Beverage Array," feeding a flexible receiving system that can be used on 160, 80, and 40 meters simultaneously. However, because all Beverage antennas must have a single feedpoint, space requirements are hard to meet.

Second Generation

Uli, DK4VW, improved the system for our 1992 activity at DLØCS. DLØCS tried to break our own German WWDX record, set by DAØBV in 1990. The location of DLØCS in Scheggerott, not far from the OZ border, is way out in the countryside with lots of space for antennas. DK4LI, a farmer, allowed us to put up the Beverage system on one of his fields, several hundred meters away from the shack. Space wasn't the problem, distance was!

DK4VW's dream was to reduce the control and signal cables into a single coax line, eliminating the need for the second cable. The plan was to use three medium-wave transmitters carrying the control information via DTMF. These low-power transmitters were tuned to three frequencies in the 400 through 700 kHz range. In the big relay box outside, there were three medium-wave receivers that did the decoding and selected the appropriate relay.

The box worked superbly on the bench. Unfortunately, one of the medium-wave frequencies selected was just 5 kHz away from a nearby broadcast station whose RF got into the box, blocking the control receivers. Unfortunately, that was only discovered after having changed from AM to FM (without success) on the control signals. Later, a series of defective relays were replaced and loose connections with cheap cinch (RCA Phono) connectors were found. Sometimes these worked and sometimes not. DK4VW and DL3LAB (Wolfgang) spent a lot of time debugging this version of the box. In the meantime, it has been successfully in use at DL3LAB and DK2OY (Manfred) for a couple of years.

Third Generation

In 1995, we were faced with a new situation. Together with the Corsica Contest Club, we set up a field day style multi-multi contest station at a holiday site on the west coast of Corsica. That year we operated as TK2C in both the SSB and CW portions of the CQ WWDX Contests. Patrick, TK5NN, had built three long Beverage antennas: one to the east, one to the west, and another to the south. However, they did not end in a single feedpoint. The space was prohibitive. All three antennas had separate feed lines entering the shack.

In a first attempt, we combined the antennas by simply feeding them to the receivers using T connectors and coax switches. This didn't work very well. In fact, we spent one entire day attempting to get the three receiving antennas working by adding different lengths of coax cable between the receivers to cancel out phase shifts. This made it possible to switch antennas without too much interaction. Still, you could hear when the guy on the other band switched antennas—not an ideal solution.

Back to the Drawing Board

In 1996 we reverted to our original idea, with slight modifications. DK4VW built yet another box with 50 ohm input and output terminals. This time, indicator LEDs were added, so one could see which antenna was selected by which station (for clarity and debugging). The box contained one split filter, 18 relays, and a power supply for feeding the logic circuitry and providing control voltage for each station. The control boxes at the three stations were identical to the earlier systems, again selecting the desired antenna by switching in the proper voltage dropping resistor in the relay box.

This new box was set up under the table between the 80 and 15-meter operating positions. Incoming and outgoing cables were connected and, it worked great from the get go, right up until the contest ended. Hallelujah! The new system contains lots of RF filtering and blocking components, making it really bulletproof. Although it has the slight disadvantage of needing separate coax lines to the individual receiving antennas, it also gives us the freedom to attach not only Beverage antennas, but just about anything else that can be used for reception.

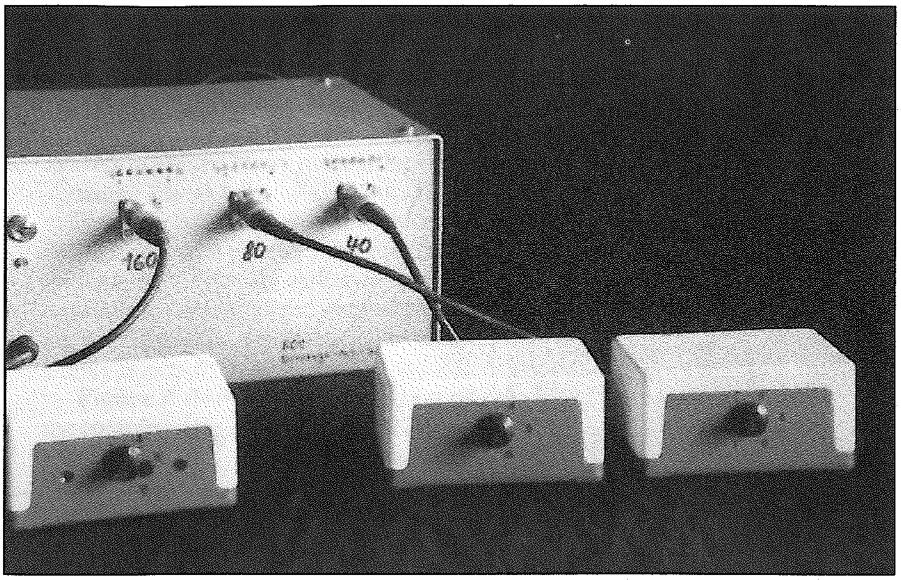

Photo A. The completed box and three operator terminals.

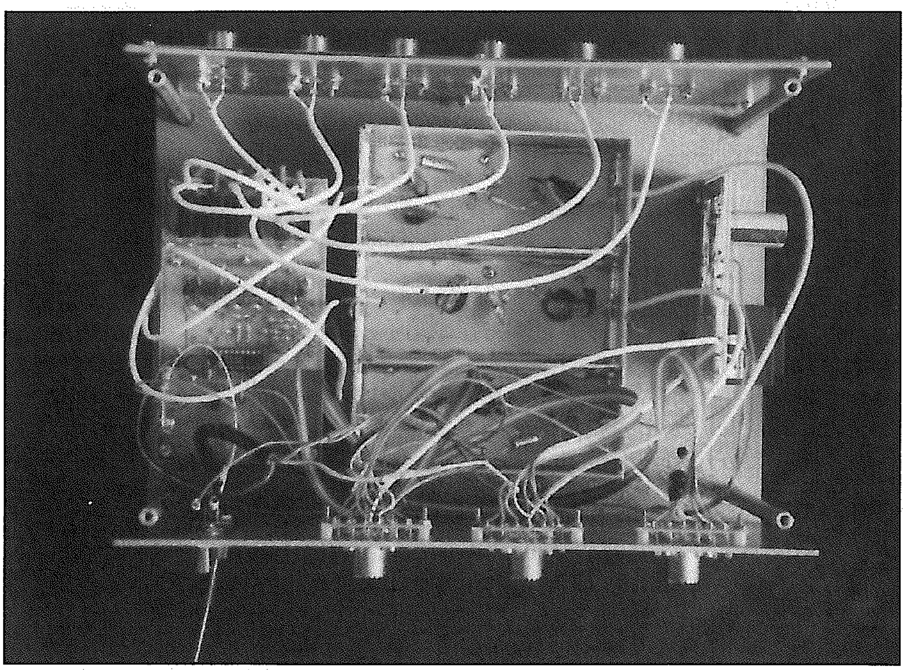

Photo B. Inside the relay box. The top of the picture shows the backside of the box with six terminals (for six antennas). A small power supply is on the right, the center is covered by the split filter and, on the left side, the digital logic boards are stacked, one for each band. The bottom of the picture shows the front of the box with three SO-239 sockets going to the 160, 80, and 40 meter station. Six LEDs on each terminal show which antenna is selected by which station.

In a contest situation, it's always good to have flexibility. For example, after this year's contest at TK1A, it seemed necessary to have an omni-directional receiving antenna (i.e., a multiband vertical or a trap dipole for reading weak EU signals coming in at high elevation angles and hardly detectable on Beverage antennas), as far away from the transmitting antennas as possible. With the new box, this can be done easily by adding an additional coax line to one of the terminals.

Circuit Description

I won't go into details of the early generations. Instead, I'll describe the final system, which has the greatest overall flexibility and may be usable for many other multi-multi contest operations. This

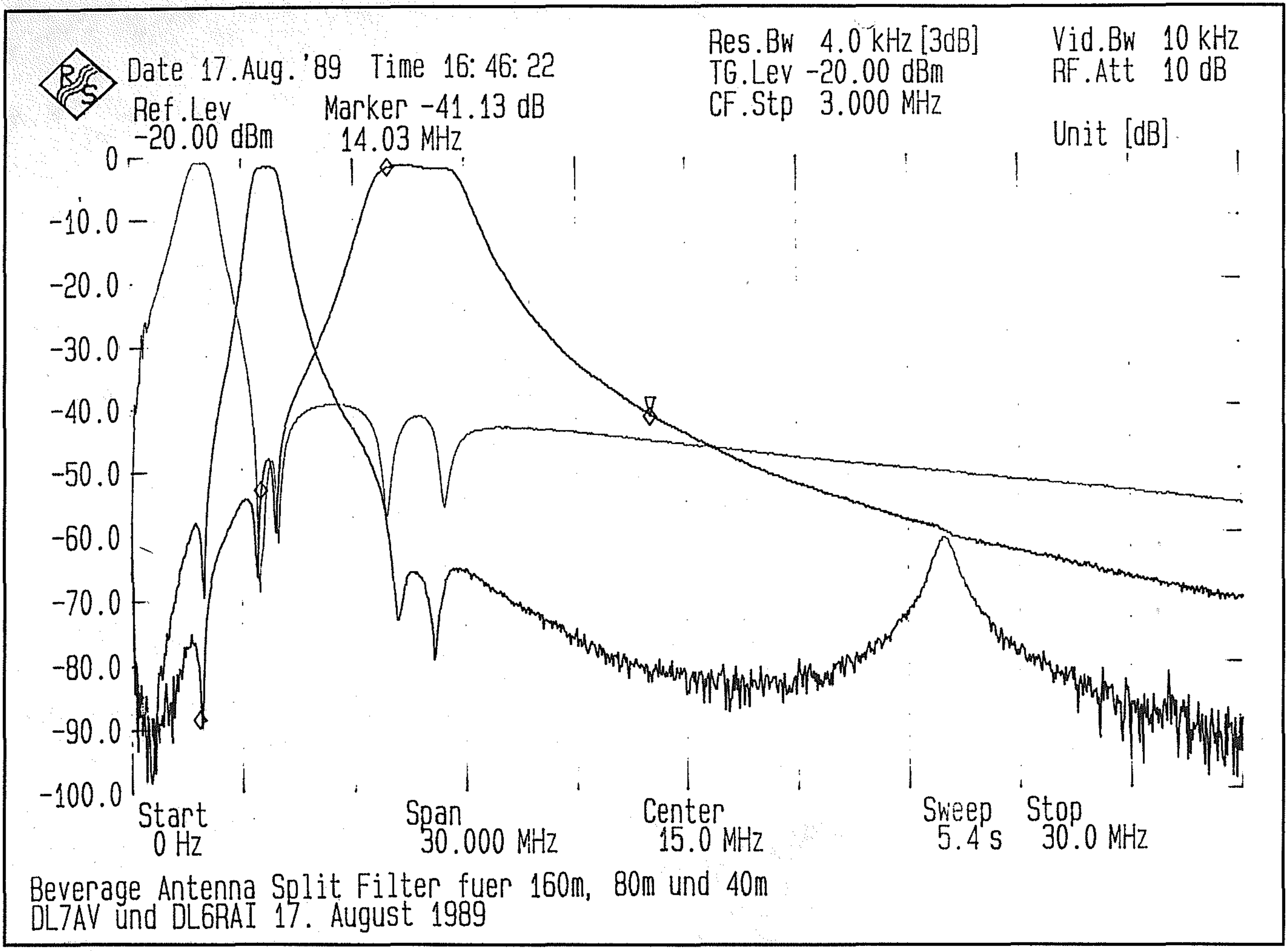

Figure 3. Diagram taken with a network analyzer, showing insertion loss of the split filter for 40, 80, and 160 meters.

system may also be used at a multi-single setup, where both the running station and the multiplier spotting station are able to access the same receiving antennas on different bands.

Receiving Antennas

If you are using Beverage antennas, it's essential to have a good match from the antenna to the coax line. We use Amidon FT-82-43 ferrite cores with four trifilar turns of enameled copper wire, 1 millimeter in diameter. The transformer is in a metallic waterproof box with a SO-239 connectors, a ground screw, and a terminal for attaching the Beverage wire. Due to the strength of the wire, the core need not be fixed, it simply is held in place by the wires leading to the three terminals. We use a simple ground rod of 30 centimeters in length to ground the box.

Run the Beverage wire in a straight line. Normally we put up one to the east (slightly north-east for the JAs), one to the south (many interesting AF multipliers), and one to the northwest (Caribbean and USA). Additionally, southeast (Indian Ocean) and southwest (South America) may be interesting directions (for European stations), too. Space is usually the limiting factor.

Beverage antennas are like a double-edged sword. The longer the Beverage antenna, the better it's efficiency and directivity; but, the more of them you'll need. It's important to keep the Beverage antennas far away from transmitting antennas. They are very susceptible to picking up unwanted noise and signals (espe-

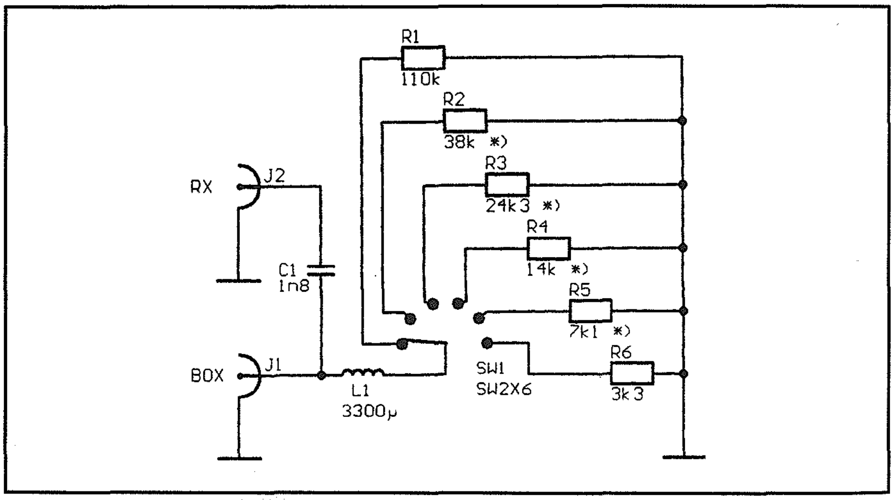

Figure 4. Circuit diagram of the operator terminals.

cially from verticals), which disturbs their performance.

The Beverage's wire is held in place by wooden poles every 30 to 50 meters. We simply wrap the wire around once and pull it straight. At the end of the wire, a 470-ohm resistor is attached with its other end grounded to the ground rod. We have had good results with antennas from 60 to 200 meters in length and 1 to 2 meters in height. We've never had enough space to try longer ones.

Relay Box

The relay box is the most sophisticated element in the receiving system. The RF signal coming in from one of the antenna input sockets is fed to three relays, one for each of the three bands. If a specific antenna is selected from, say the 80-meter station, a relay is activated and switches that antenna to the input of the 80-meter split filter. The split filter takes out the 80-meter component of the RF sum signal and feeds it through the terminal to the 80-meter station through a DC/RF filter.

You may wonder why a split filter is needed here. The 80-meter receiver's stop band impedance, together with its feedline, may appear as a short circuit in the 160 and 40 meter range. If so, using the antenna with the 80-meter station would make it useless for the other two bands, as signals would be very weak or nonexistent. The split filter isolates the 80-meter receiver from the other two, making interaction between the three receivers negligible. The schematic of the split filters is shown in **Figure 1**. It consists of three band filters tuned to the 160, 80, and 40 meter bands, with a high impedance in the stop band. **Figure 2** shows the measured insertion loss for the three filters in a single diagram, and the first generation filter built for the LX7A operation.

The other side of the DC/RF filter, the input (Pin 5) to the LM3914 LED driver circuit, measures a voltage. This is a linear dot/bar display driver that, when used in dot mode, activates a specific output pin depending on the voltage level applied to the input. The input voltage, again, is a result of the voltage divider in the relay box and the terminal at the station receiver.

This is the control voltage that's used to select a specific antenna.

The LM3914 drives both the PNP driver transistors and the indicator LEDs through pins 10, 11, 12, 14, 16, and 18. Up to ten voltage levels are possible with the LM3914. We used only six positions here (3.0, 5.0, 7.0, 8.5, 9.5, and 11.0 volts). To achieve these voltage levels, we used voltage dividers of 10 k/3.3 k, 10 k/7.0 k, 10 k/13.9 k, 10 k/24.3 k, 10 k/38 k, and 10 k/110 k. The resistors marked with an asterisk in **Figure 3** were made using combinations like 6.8 k + 200 ohms. These resistors are critical as they determine the voltage level that activates the next relay. Because we're dealing with antennas in a transmitting environment, careful blocking and filtering is required to avoid undesirable effects from spurious RF.

Figure 3 shows a circuit diagram of the complete relay box built by DK4VW, as it was used at TK1A in the 1996 Phone CQWW DX Contest.

User Control Terminals

There are three control terminals attached to the relay box, one per band. The terminals consist of a DC/RF split filter, two SO-239 sockets, and a switch that selects the appropriate resistor [combination]. The RX side of the terminal goes to the receiver input (without the DC); the other side is connected to the relay box outlet for the selected band. This cable also carries the DC component that makes the relay box switch to the selected antenna.

Photo A shows the relay box and the three terminals. **Photo B** provides a look inside. **Figure 4** is a circuit diagram of the box. This setup was used at TK1A in the 1996 CQ WWDX Phone Contest.

Conclusion

DK4VW has built a second version of this box that will be used by the DLØCS contest group in the years to come. Uli has incorporated a double-sided pc board in this version. If you'd like to try it, a short description and the layout is available in a Postscript file from the BCC home page at: <http://www.rrze.uni.erlangen.de/~unrz45/BCC/projects/bev_box/>.

I've just divulged one of the BCC's contest secrets. Like many other things in our club, this receiving antenna system evolved over many years as a result of several people's cooperation and experience in multiple contest situations. As you can imagine, going public with this information was a hot topic at our monthly roundtables. I'm sure many of you have similar stories to tell. I hope this article inspires you to share your experiences with us, in the interest of "Ham Spirit."

Hope to hear you (and to be heard!) in the next contest(s). Thanks to DJØIP, DL2NBU, DL7AV, and DK4VW for their assistance in writing this article. ■