

## The K6XX Automatic Antenna Selection System

Over the past decade, several incremental station automation attempts have evolved at K6XX, all seeking a simple and equipment-safe means of routing the correct antenna to the right radio. Starting with a simple relay-driving band decoder for one rig, the system progressed through a semi-automatic controller for two radios (SO2R), into a completely automatic antenna selection system for up to six rigs. During this development, guest operators reported confusion—sometimes leading to equipment damage—due to the non-intuitive, haywire nature of these experimental blocks. Thanks to these operators' feedback, the entire automatic antenna selection concept was improved and simplified. Now, the only required operator input is *direction* ("Which way do you wanna beam?"), and is controlled by a single knob. Each transmitter/amplifier always sees a suitable antenna for its band, and full protection keeps things safe.



**Figure 1. The Operator Console and Display (for Station 4). Note the Azimuthal map inside the direction control.**

### What Is It?

This system allows routing multiple (up to 36) antennas to six stations. It is designed for stations with multiple fixed-azimuth antennas, and works with single, SO2R, or multi-transmitter configurations. The operator chooses one (or more) beam directions and the system automatically connects the correct antenna(s) to that particular station.

What does this mean? It means the station comes close to “power-up & play”. It means the transmitter/amplifier always sees a decent impedance match. It means each receiver has automatically-selected band pass filter protection. It means a guest operator (or sleepy owner) may run the station without destroying things. It means that if things break anyway, another station is immediately ready to take over.

An operator sitting down at any one of the six stations has every antenna available to his station—cable swapping is never required. SO2R? Sure. Two sets of two stations (that means four transceivers/amps) are ready for SO2R without any reconfiguration. M/2 or M/M? QRV. All stations are offered equal capability; none are crippled for the sake of another.

Potential inter-station hazards are detected and prevented, since receiver front-ends must be protected from transmitters, whether on the same or on different bands. A hardware (*no* software involved) controller tracks which band each station is using and prevents deadly antenna sharing. Relay-switched band pass filters keep cross-band QRM out of receiver front ends.

### Configuration

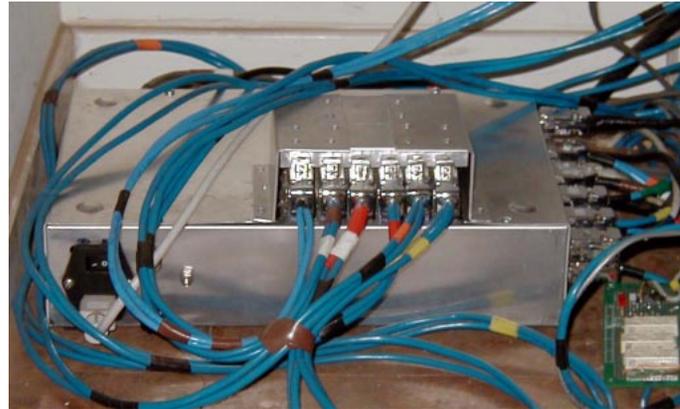
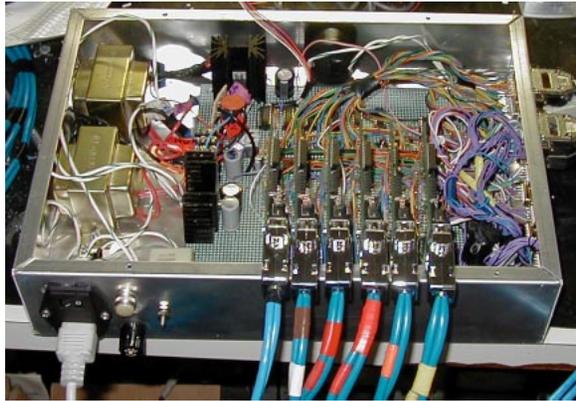
The antenna system consists of four blocks: the operator’s **Console**, the **Controller**, the antenna-band **Matrix**, and the **Direction** relays.

The operator’s **Console** (Figure 1) consists of a direction selector and rig interface. There are six Consoles, one at each station. Direction selection is accomplished by a combination of a rotary switch and toggle switches, arranged around an azimuthal equidistant map (a “beam heading” map) centered on my QTH. Most of the time the rotary switch is used, since it is much faster to twist a rotary knob than to turn OFF one toggle switch and turn ON another, as often occurs when checking propagation in another direction—to hear a VK or LU calling while beaming JA, for example. If situations require beaming in multiple directions, the toggle switches are used, alone or in combination with the rotary switch. Up to six azimuths may be chosen simultaneously. LEDs circling the map depict which direction(s) are active.

The **Controller** (Figure 2) reads the band data from each station and checks for contention. If all is OK, the direction data is routed to the proper Direction relay, and the antenna band Matrix is instructed which bank of antennas (basically, which band) is routed to which station. If contention is detected—meaning that more than one station is trying to use the same band—all antenna relays are locked down in their last safe state, an obnoxious klaxon horn sounds, and a bright red LED on each Console illuminates. Amplifiers are disabled during the fault.

### Console (Operator & Rig Interfacing) Functions:

- Read Band data from rig
- Allow manual band override (for testing or when something breaks)
- Send Band and Direction data to Controller
- Drive BPF relays
- Latch band and direction data during transmission to prevent hot-switching relays
- Amplifier T/R control buffering
- Amplifier Disable (when band contention fault occurs)
- Tells Controller to power-up



**Figure 2. Controller (A) innards. (B) Buttoned up and operating. There are many more wires beneath the board!**

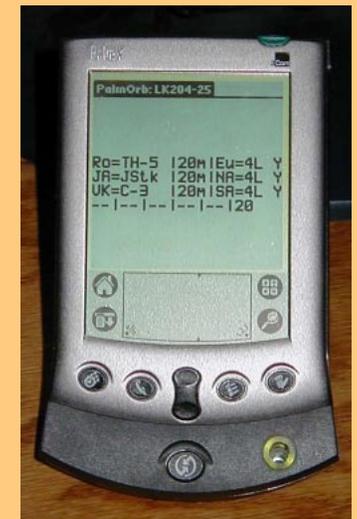
Independently, a Basic Stamp programmable controller reads band data from each station, processes this information, and pipes it to a small display (Figure 3) next to each operator console. These displays, built from old Palm Pilot handhelds, show which antennas correspond to which switch direction on the Console, as well as which band each of the other stations is presently using. While not necessary for system operation, it lets a guest operator see what choices are available in each direction. It has also proven invaluable for debugging, by showing which relay positions the controller *thinks* it is selecting; comparing this information to which relays are actually driven has helped quickly narrow down wiring problems. (Alright, I'll admit another use: it helps **me** remember what hardware is up in the air, too!)

The antenna-band **Matrix** (Figure 4) is a bank of relays that directs a band's worth of antennas to a given station. Formerly built with a large number of discrete coaxial relays, it now consists of three Array Solutions SixPaks, interlaced with small diameter hardline. This new configuration is much less reminiscent of a rat's nest, but still uses lots of cabling.

Finally, the **Direction** relays select one or more antennas and route them to the Matrix. There are six Direction relays, organized primarily by band: 160m/WARC, 80m, 40/60m, 20m, 15m, and 10m. The controller allows another Direction relay dedicated for VHF, but this has not been integrated. Of the six available directions, five are fixed on the most important azimuths for Northern California contesting, and the sixth is for a rotatable or omnidirectional antenna.

### Other Flexibility

Predictably, I cannot leave well enough alone, and have built in more layers of complexity—errr, I mean more "features". For example, another switch selects a secondary antenna bank, in case the primary bank develops a fault. A *band segment* switch drives the Phone/CW relay sometimes needed by



**Figure 3. Palm Pilot PDA at each station shows available antennas. This view indicates that Station 4 is on 20m and all other stations are QRT.**

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narrow-bandwidth low-frequency antennas. A band pass filter disable switch allows measuring antenna SWR or SWLing outside the ham bands. Also, a manual band switch will override the automatic selector. Guest operator may (should!) generally ignore all of these features. With the exception of the BPF disable—which, when activated, lights a bright red warning LED on the operator Console—the controller is smart enough to work with all of these options and prevent damage.

There are a few multiband antennas in use here. The controller knows about them and drives a demultiplexing relay to route each antenna to the required band matrix port (and locks out this antenna for all other stations).

### **Future Enhancements**

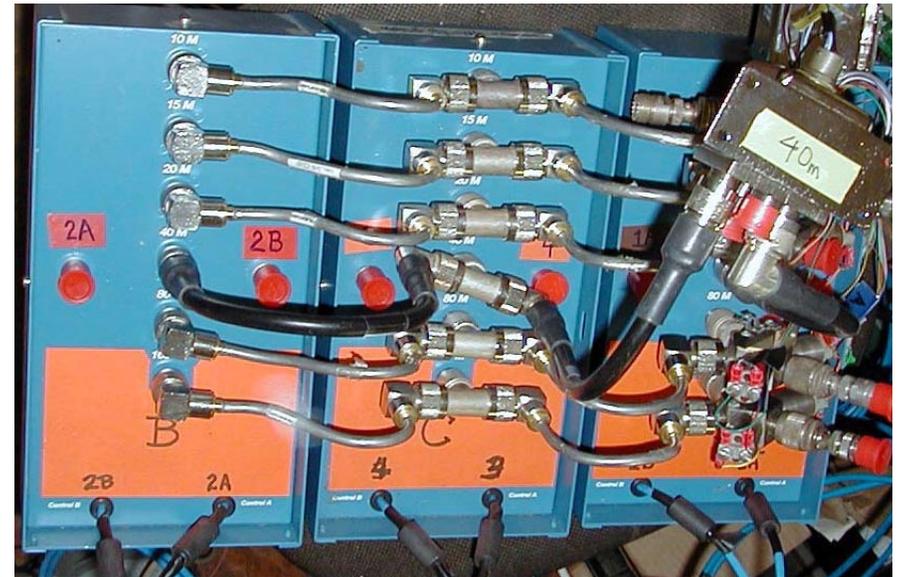
Its working, but it ain't done! Three additional PC boards are planned. One will replace the controller board, which is a troubleshooting nightmare with its several hundred separate wires. Another will simplify the way the band segment switching (phone/CW) relays are driven. And another will help flatten the SWR between stations by equally distributing the antennas to the matrix (eliminate some short stubs) and will provide switchable impedance matching to accommodate load variation when single or multiple antennas are used simultaneously.

Rotator and StackMatch sharing, providing control access to all stations, is also required. Presently, the Beverage receive antennas are available to all stations—but only two at a time—by manually switching coax cables at a hub and activating a selector “wand” for those two stations.

### **Summary**

The K6XX Automatic Antenna Selection System, under development for years, has evolved into a fully-automatic antennas-per-band configuration. Long-term testing of incremental improvements plus valuable feedback from guest operators has shaped what began as a much simpler single-transmitter or SO2R automatic antenna relay driver into a system accommodating 36 antennas fed to six simultaneously operating stations.

Once the operator turns on the rig (which powers up the controller), tunes a frequency (on the rig), and selects a direction (on the Console's six-position switch), the proper antenna is automatically routed to the rig. Built-in protective features allow safe operation of all six stations, depending upon antenna availability—and band conditions, of course!



**Figure 4. The Antenna-Band Matrix consists of three “SixPaks”.**



**Figure 5. K6XX S02R Station 1 showing the antenna select system operator interface.**