Intuitive StackMatch Control

by Bob Wolbert, K6XX

The StackMatch by Array Solutions (a.k.a. WX0B) controls a stack of two or three antennas. Its optional control box has a vertical line of LEDs that clearly indicate the selected antenna(s), but uses a rotary switch to select one of the various possible configurations. But which switch position corresponds to which configuration? And, which antenna is represented by the little square symbol, and which one is the circle?

This control box also needs four wires (plus ground) to pick one or more of the three antennas. Using this hardware with two antennas requires three control wires.

Simple and obvious station operation is important—let those brain cells concentrate on the second (or third?) receiver, not mechanical station operation! Instead of deciphering geometric shapes, an instantly understandable, intuitive control box is desired. Reducing the number of control lines is another important goal, as the arrays around here are hundreds of feet from the shack. Two designs accomplishing these goals are presented, one that selects from a three-antenna stack, the other optimized for a two-stack.

Three-Stack Controller

How best to intuitively select antennas in a stack? After very little thought, a column of toggle switches and a matching column of indicator lamps was chosen (see Figure 1). Designed for left-hand control, the LEDs are to the right of the switches so one's hand and arm do not block the view. Reverse the switches and LEDs for right-hand operation.

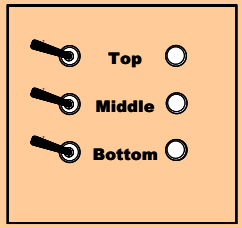


Figure 1. Three-Stack Control Panel.

The next design problem is determining the logic interface from this toggle switch control panel to the StackMatch. Reviewing its schematic, which appears on page 11-43 in the 20th Edition of the ***ARRL Antenna Book***, we deduce the StackMatch truth table (Table I). Since the StackMatch defaults to the full stack when no power is applied, the control box must accept two states for the full stack: all switches ON and all switches OFF.

Circuit implementation is shown in Figure 2 and Photo 1. An old-style TTL gate with high voltage open collector outputs, the 7445 (outputs rated to 30V) or the 74145 (outputs rated to 15V maximum) is used, along with some signal diodes to complete the logic. Please note the 330Ω resistors connected to the switches are semi-critical; much higher values cause the low-state input voltage to exceed TTL specs, and smaller values allow too much current through the LEDs. Precision resistors are definitely not required. At only about 40mA per output, the StackMatch is not a difficult load to drive, and "garden variety" PNP switching transistors like the 2N3906 are suitable. Figure 3 shows a number of different output circuits: build with whatever component types you have available The options using relays are less likely to suffer damage from nearby lightning strikes. Table II shows the measured current drain of my prototype using a 7445 and PNP Darlington outputs.

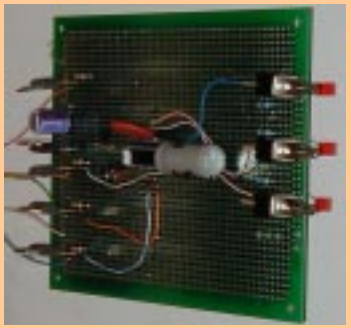


Photo 1. Three-Stack Prototype.

Note that four control wires are still required for this circuit. I decided that the extra complexity and potential RFI issues resulting from placing the control logic inside the StackMatch was not worth saving one wire run. When using this controller design, no changes are necessary inside the StackMatch unit.

Table I. StackMatch Controller Logic for a Three-Stack

Toggle Switch (and Antenna)	Control Line			
	IN	**3**	**2**	**1**
Top + Mid + Bottom	0	0	0	0
Top + Mid	0	0	0	1
Top + Bottom	0	0	1	0
Mid + Bottom	0	1	0	0
Bottom	1	0	0	1
Mid	1	0	1	0
Top	1	1	0	0

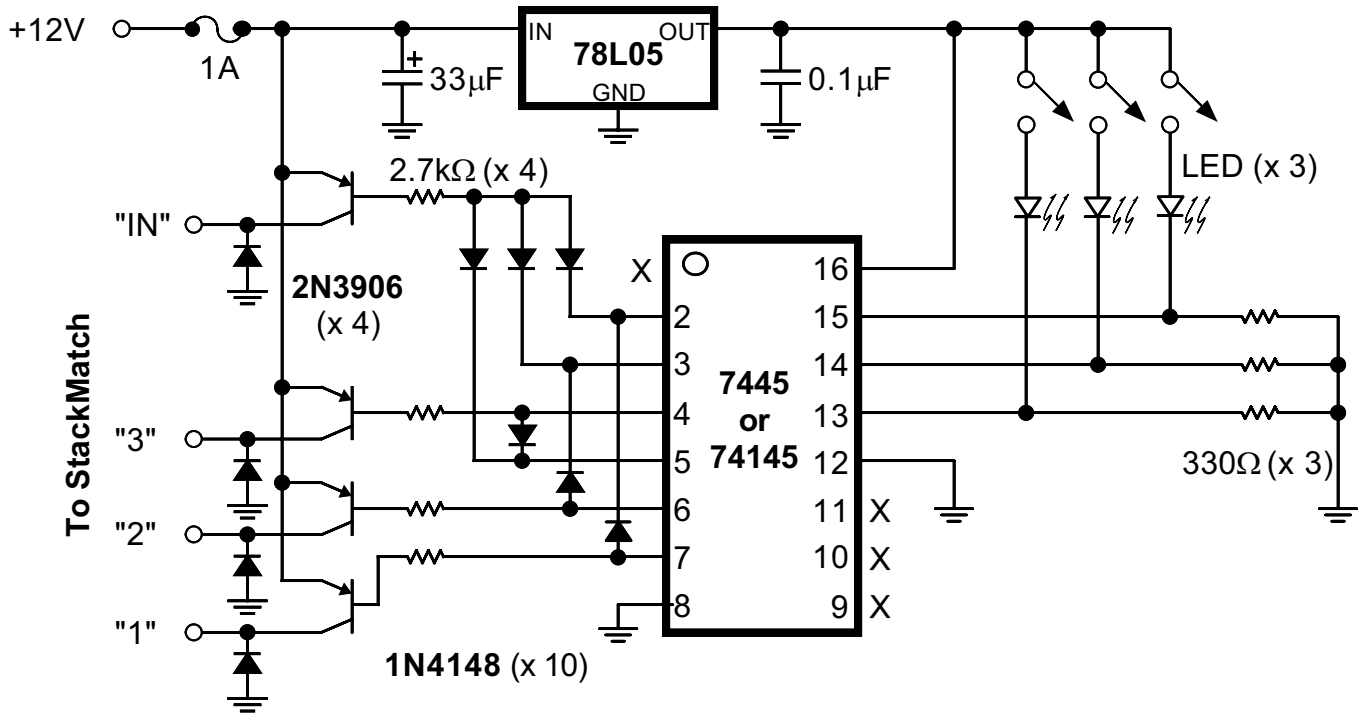
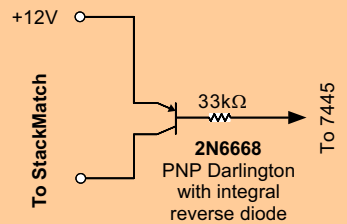
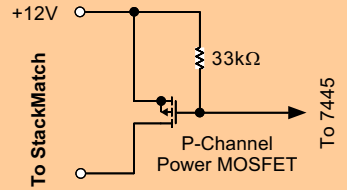


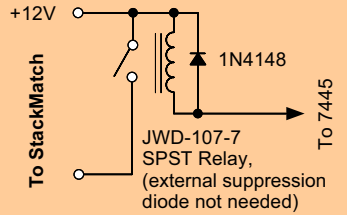
Figure 2. Three-Stack Controller using PNP output Transistors.



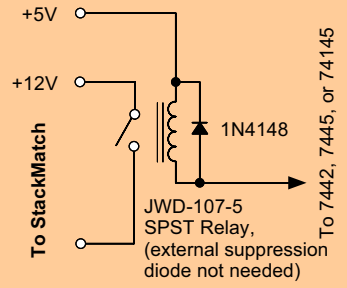
(A) PNP Darlington with internal diode



(B) P-Channel Power MOSFET



(C) SPST Relay with 12V coil



(D) SPST Relay with a 5V Coil.

Figure 3. Three-Stack Output Options

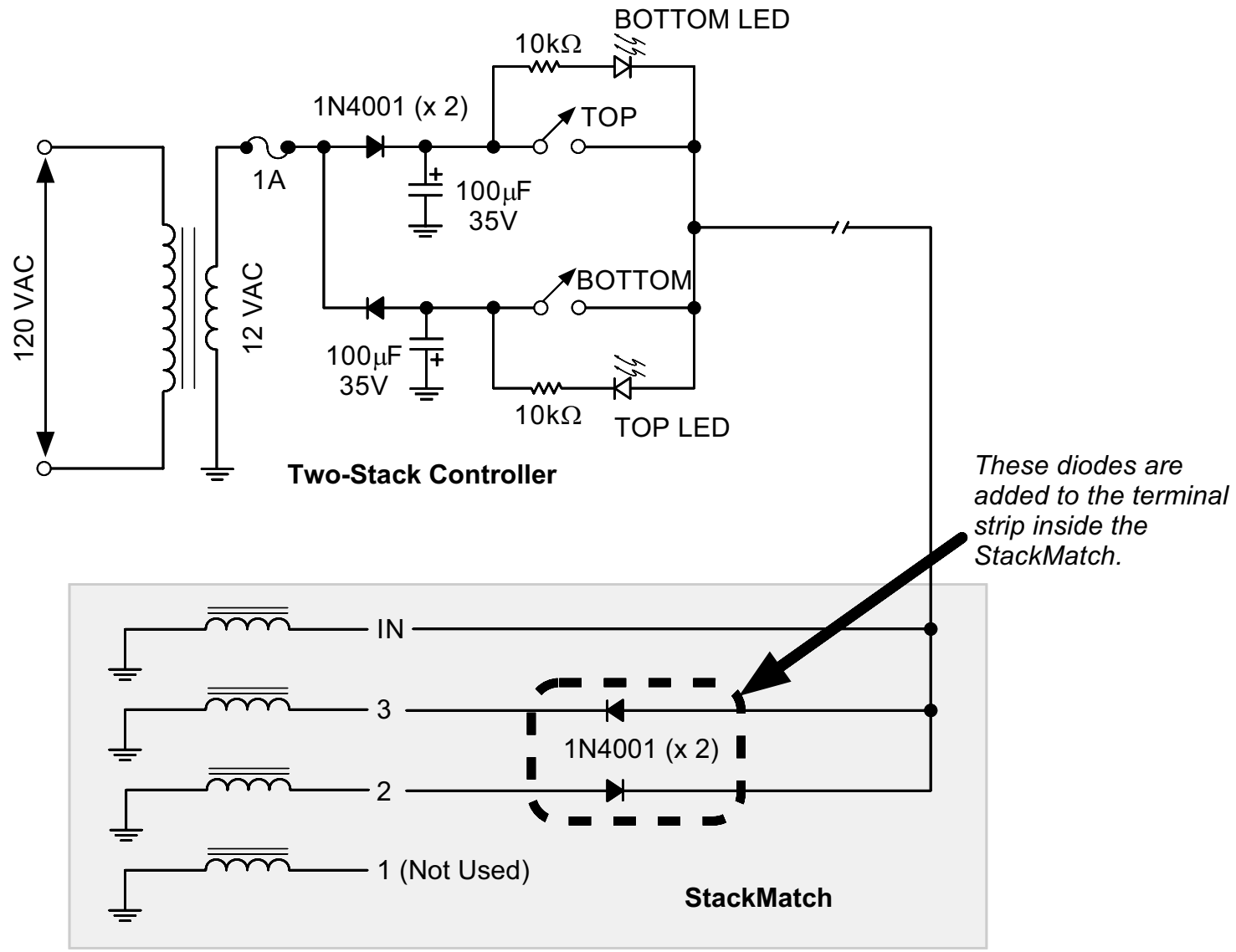


Figure 4. Two-Stack Controller and Additional Diodes Needed Inside the StackMatch.

Two Antenna Stacks

If a stack has only two antennas, we can design a control box that reduces the wiring requirement from three to only one wire. Using both positive and negative drive voltages this may be accomplished as described in Table III.

Table II. Current Drain (Figure 2), V_{IN} = 13.6V

Configuration	Current
All Switches OFF	38mA
All Switches ON	60mA
One or Two Antennas Selected (worst case)	144mA

Table III. Single-Wire Controller logic.

Switch	Voltage	Antenna
(none)	0	both
Upper	+12	Top
Lower	–12	Bottom

Figure 4 shows the two-stack design. No ICs or transistors are required. Since the control box needs –12V, and no other use for this voltage presently exists at K6XX, a dedicated power supply was designed using an AC output "wall wart" (a small 12.6V transformer is also suitable). A semi-tricky aspect of this circuit is the LED display, which must have both LEDs ON when the relays are OFF, and is accomplished by shorting out the *opposite* LEDs by the control switches. In other words, the TOP control switch shorts out the BOTTOM LED, and vice-versa. The LED current passes though the StackMatch relay coils, so they will not illuminate unless the StackMatch is connected. This small current (about 1mA) is insufficient to either trigger or hold the relays, so their operation is unaffected. However, only 1mA is less than the 10mA normally used for LEDs, so if you find their luminosity too dim, consider changing to high efficiency LEDs. Do not reduce the current-limiting resistor values or else the StackMatch relays might not release after they have been activated. On my prototype, 50mF of filter capacitance was required on both the positive and negative supplies to eliminate relay chattering due to the half-wave rectified 60Hz. I recommend using at least 100mF of filtering on both supplies to provide some margin, unless a negative DC supply is available.

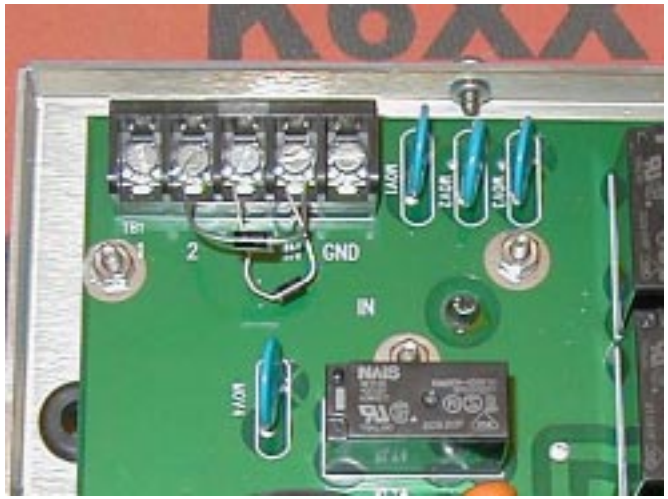
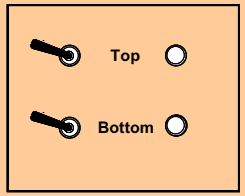


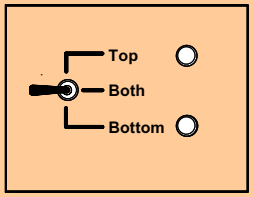
Photo 2. Diodes necessary inside the StackMatch for the single-wire two-stack controller

Figure 5 shows two possible control panels. Some may find the two-switch version is more intuitive, but the single switch version allows faster, single-finger stack selection and optimization—with it, UP is the top antenna only, CENTER is the full stack, and DOWN is the lower antenna only.

Two diodes are added to the StackMatch when used with the single-wire controller. This is a screwdriver-only operation—no traces must be cut and no soldering is involved. The diodes are easily installed on the internal control wire terminal strip, as shown in Photograph 2.



(A) Two SPST Switches



(B) SPDT, Center OFF Switch allows faster stack checking..

Figure 5. Two-Stack Controller Panel

Summary

RF-wise, the StackMatch is a well-designed system for selecting among antennas in a stack. The control box from Array Solutions, however, is not as well thought out. The controllers presented here allow more intuitive and simpler means of selecting your stack.

ver 1.01 2Jy04