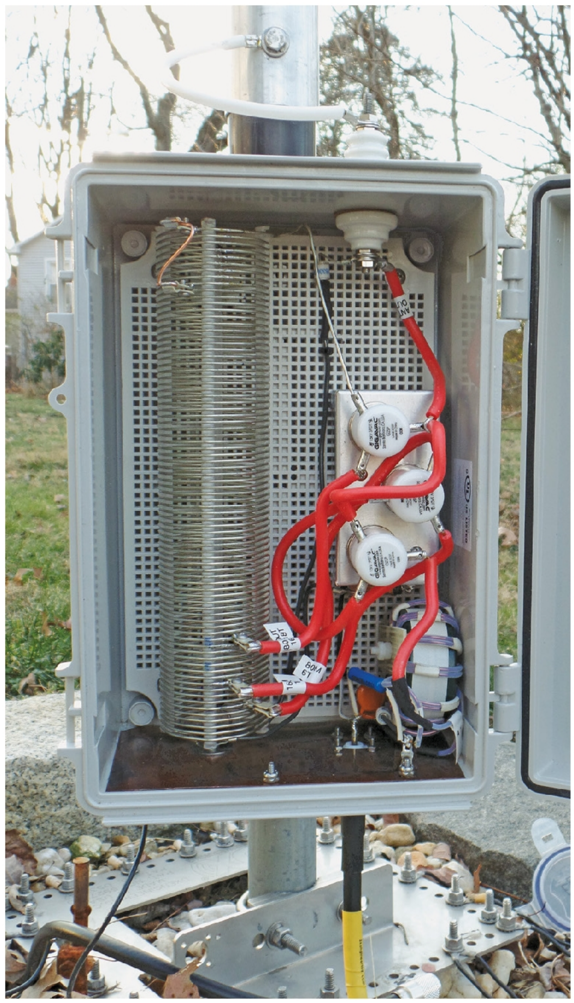
An Improved 160/80-Meter Matching Network for Your 43-Foot Vertical

Put your 43-foot vertical antenna to work on two popular "low" bands.

Steve Masticola, WX2S



I decided to add a ZeroFive Antennas tilt-over 43-foot mast to add 160-meter capability to my station. The system must be matched at the antenna, or most of the power output is lost in the transmission line.

I based my match design on a Phil Salas, AD5X, article.[1] That design soon failed. Subsequently, Phil advised me that my antenna grounding system might have been too good for his original design. He had assumed at least 10 Ω of ground loss, which made the Array Solutions relays he specified marginally adequate, at 1,500 W on 160 meters. This is how I beefed up Phil's design (see the lead photo).

An Upgraded Match

I substituted three 15 kV vacuum relays for the two RF-3PDT-15 parts, and enclosed all the relay control electronics in a grounded mini box to minimize the possibility of RF getting into the relay controls. I kept the lead lengths to the absolute minimum for the dc control voltages outside the mini box, and bypassed those leads as they entered the mini box. I installed a 7.5 kV gas discharge tube (GDT) for relay overvoltage protection, and added a second 1 kV GDT and bleed resistor to the RF input for built-in static discharge protection.

I used three Gigavac G2 SPDT vacuum relays in the improved design.[2] Equivalent Taylor VC2F-13.2 vacuum relays are also available from RF Parts (**https://www.rfparts.com**).

I added a 7.5 kV dc GDT between the antenna output and ground (see Figure 1).

Phil's updated online article[3] includes a variant that uses a bias-T to deliver the control voltage. I adopted this variant. A second 1 kV GDT in parallel with a 25 MΩ bleed resistor provides static protection. External dc-blocking static protectors cannot be used with this design because they block the control voltage to the unit. I used another G2 vacuum relay for K2. Unlike Phil's design, the loading coil remains in circuit on 60 meters and up. This arrangement costs 0.6% and 0.5% power loss at 30 and 40 meters, respectively.

Assembling the Match Box

I chose a Bud Industries NBF-32316 NEMA box for the enclosure, added a Bud Industries NBX-32916-PL internal grid panel, and mounted the coil and relay mini box on it. The NEMA box is designed to accept the grid panel without the need to penetrate it with screws.

First, mount the coil to the grid panel, as seen in the lead image and in the *QST* in Depth images.[4] Zip tie two pairs of polyethylene standoffs sideways on the left side of the grid panel, then zip tie the coil to the grid so that it is held slightly off the grid by the standoffs. Solder a #8 lug onto the bottom end of the coil where the coil will be closest to the ground plate.

Next, cut the ground plate to shape and glue it to the bottom of the NEMA box. Use an adhesive that is compatible with metal and ABS plastic, such as RTV sealant or an epoxy glue made specifically to bond ABS to metal. Allow the adhesive to set overnight.

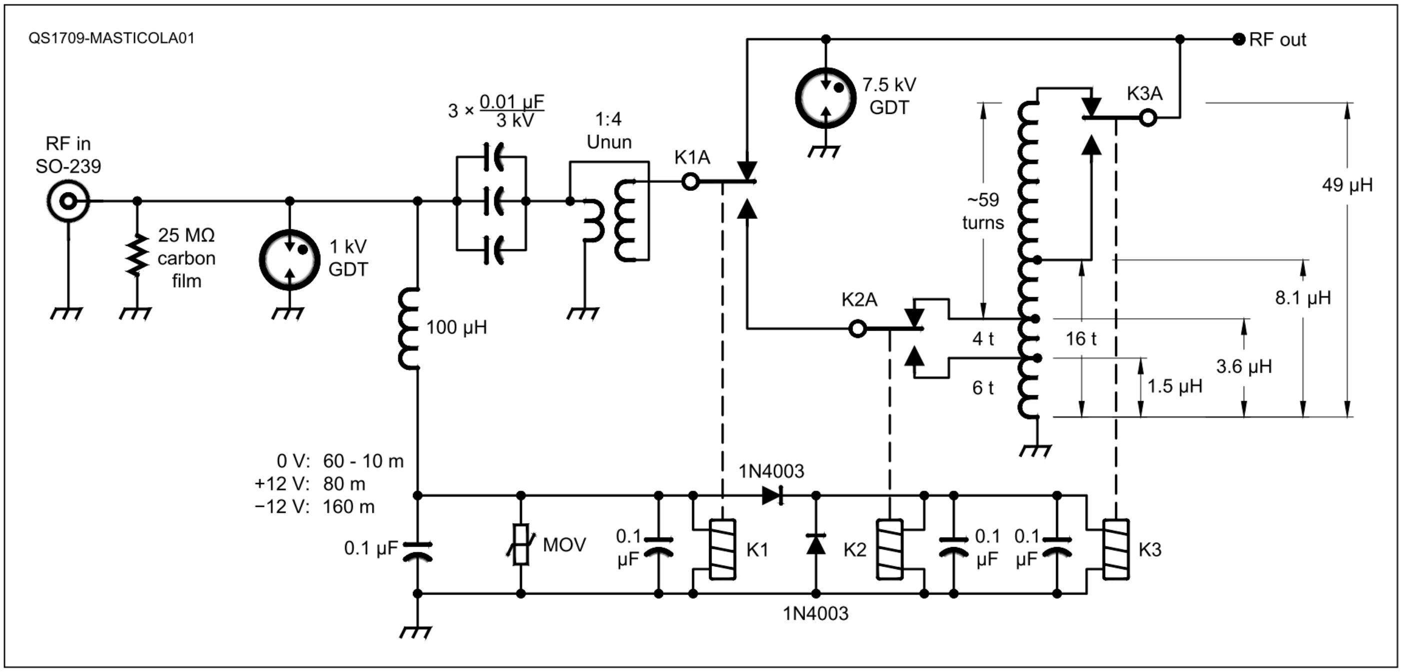


Figure 1 — A schematic of the load box. The parts list is available on the *QST* in Depth web page, at **www.arrl.org/qst-in-depth.**

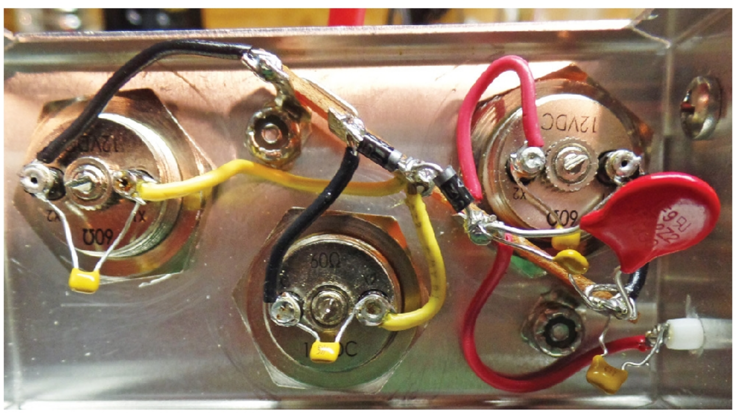


Figure 2 — The vacuum relay wiring. The red wire controls K1 on the right. The yellow wires control K2 and K3 on the left. Make all leads as short as possible.

Mark the location of the SO-239 connector on the bottom of the NEMA box. Using a step drill bit, drill a hole that is just wide enough for the SO-239 through the box's bottom and the ground plate. Drill screw holes for the SO-239, and attach it from the inside with 4-40 stainless-steel screws. Install a ground terminal near the SO-239 connector for the static protection electronics. Drill a hole on the top right of the NEMA box for the feed-through insulator.

Rest the grid assembly inside the box and mark the center of the coil. Take out the grid assembly, and drill a hole for the 8-32 ground terminal.

Put the grid assembly back in the NEMA box and place the 1:4 unun on the right side of the box, then mark and drill a mounting hole. Secure the unun to the box with a 6-32 stainless-steel screw and a small piece of scrap circuit board or stiff plastic.

Take a socket that fits the mounting nuts of the relays and use a pencil to trace the edge of the socket on the inside top of the relay mini box, equalizing any overlap. This will ensure that you will have enough space to tighten the nuts of the relays. Using your step drill bit, drill the mounting holes for the relays in the top of the mini box. Bolt in the vacuum relays loosely, position the terminal strip for the electronics and mark its mounting holes. Take the relays out, and drill the terminal strip mounts for 6-32 screws. Drill holes on the top right side of the mini box for the control feed-through and a grounding screw for the mini box.

Next, install the vacuum relays, terminal strip, feed-through, and ground lug in the mini box, wire the relay control circuit (see Figure 2), and test it. With +12 V applied between the feed-through and the mini box, all three relays should be energized. With –12 V applied, only K1 should energize.

With the grid and 1:4 unun in the NEMA enclosure, position the mini box on the grid. Mark screw holes and drill the grid and mini box bottom. Mount the mini box bottom to the grid with 6-32 stainless-steel screws and snap the relay assembly onto it. You should have enough space left to wire the unun to the K1 common input.

Take the mini box out and wire the relay terminals (see the image on the *QST* in Depth web page) using high-voltage wire, except for the unun terminal (K1 common input). Pre-tin the ends of the wire and flow solder into the bottoms of the vacuum relay terminals. You should not fill the terminals up with solder.[5] To avoid arcing, do not run the wires too near the edges or corners of the mini-box.

Finally, solder the 100 µH choke to the feed-through using as short a lead as possible. Solder a piece of #18 AWG solid hookup wire to the long lead of the choke. Shrink-wrap this joint and tie the hookup wire to the grid, leading down to the SO-239 connector.

I separated the ground wires for the mini box and the 7.5 kV GDT to reduce coupling, and ran them directly to the ground post under the coil. To connect the antenna, I used a short length of #14 AWG marine-grade high-voltage wire with ring terminals at either end.

Testing

With power off to the bias-T, the unun output (K1 common terminal) is connected to the feed-through. With +12 V applied through a bias-T, the common terminal of K1 is connected to the 80-meter coil input, and the 80-meter output (K3 normally open terminal) is connected to the antenna. With –12 V applied, the common terminal of K1 is connected to the 160-meter coil input (K2 normally open terminal), and the 160-meter output (K3 normally closed terminal) is connected to the feed-through. It will also be connected to ground at dc through the coil, and K1 common is always connected to dc ground through the unun.

Drill four 1⁄16-inch weep holes in the bottom of the NEMA box, through the ground plane, and two downward-slanting weep holes in the upper sides of the door. These will prevent moisture buildup inside the box.

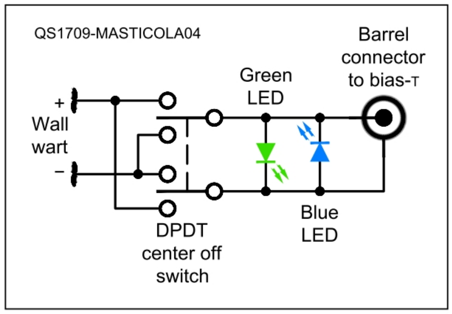


Figure 3 — The control box schematic.

The ZeroFive 43-foot vertical comes with a mounting plate for its included unun. I saber-sawed a larger mounting plate for the NEMA enclosure from ⅛-inch aluminum plate that goes in its place. If you must take the matching network off, you can put the unun back on and keep your antenna working on 80 meters and higher.

The Control Box

The control box wiring (see Figure 3) applies +12 V, –12 V, or 0 V to the bias-T in the shack. I added a blue LED to indicate 160-meter operation and a green LED to indicate 80-meter operation. I connected the control box via Anderson Powerpole® connectors to the wall wart. That way, I can run it from a battery outdoors while setting up the matching network.

Tuning the Match Box

First, build two test leads using an alligator clip and a micro clip on a short piece of stranded wire, and a shorting wire consisting of a short piece of #14 AWG copper wire with a coil clip on each end. I use coil clips soldered to the coil to ensure that the connections remained solid. Connect an antenna analyzer and a bias-T, switch the network to 160 meters and short out the top turns of the coil with a test lead until the resonant point of the matching network is at your preferred frequency. Solder the coil clips of the shorting wire in place. Next, switch the network to 80 meters, and find the correct point to attach the 80-meter output lead. Solder its coil clip to the coil.

On 160 meters, the network will lower the SWR over a narrow frequency range to the point that your shack tuner can match the antenna. The 80-meter SWR is reasonably low across the whole band.

Operating

The 12 V dc source, capable of 600 mA, must be isolated from your radio power supply.

I can run about 900 W into the matching network on 160 meters before the GDT fires to protect the relays. I earned 160-meter DXCC in less than a winter season.

Many thanks to Phil, AD5X, for all his help in making the new design happen.

Notes

[1]Phil Salas, AD5X, "160 and 80 Meter Matching Network for your 43-Foot Vertical — Part 2," *QST*, Jan. 2010, pp. 34 – 35.

[2]**www.gigavac.com/catalog/amateur-radio**

[3]Phil Salas, AD5X, "160- and 80-Meter Matching Network for your 43-Foot Vertical — Updated," **www.ad5x.com/images/Articles/Match43footerRevA.pdf**.

[4]**www.arrl.org/qst-in-depth**

[5]"Soldering Wires to Gigavac High-Voltage Relays," **www.gigavac.com/application-notes/high-voltage-relays/soldering-wires-gigavac-high-voltage-relays**.

Photos by the author.

ARRL Life Member Steve Masticola, WX2S, has been licensed since 1971. He holds a Ph.D. in computer science and worked professionally in both computer hardware and software research and development before he entered technical management. His ham interests include DXing, CW, the QRP Fox-hunt, building ham gear, and keeping the power line interference at bay. He is one of the many Presidents of the Siemens Fire Safety USA Amateur Radio Club, KF2IRE, who organize the annual Fire Prevention Week Special Event (**www.hamfire.com**). You can reach Steve at **wx2s@arrl.net**.

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