# 160 and 80 Meter Matching Network for Your 43 foot Vertical — *Part 2*

*This dual band matching section design provides for remote band changing.*

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In Part 1, I described a simple 160 and 80 meter base matching assembly for a 43 foot antenna. While that unit is very effective and inexpensive to build, it is also a little inconvenient in that you must connect it when it is needed, and you must also manually enable 160 or 80 meter operation using straps. This month, we'll look at a more versatile matching assembly that is completely remote-controllable for operation on all bands. Again, this base matching network will significantly eliminate SWR-related coax losses and unun mismatch losses, and assist inside tuners in providing a match on 160 and 80 meters.

## The All Band Matching Solution

As discussed in Part 1, a 43 foot vertical antenna requires approximately 50 µH of inductance to resonate the antenna. On 80 meters, approximately 9 µH is needed for resonance.  For the matching solution shown in Figure 1, I used an MFJ 404-0669 air wound coil and two Array Solutions RF-30 relays for up to full legal limit matching on all bands from 160 to 10 meters. A 2.1 × 5.5 mm dc power jack located below the SO-239 connector provides for relay control voltage inputs of 0 V, +12 or –12 V dc. The control input MOVs and bypass capacitors are mounted on a 6 terminal strip inside the matching assembly.

The matching unit operates as follows: With no control voltage applied, the inductor is disconnected and the unun is connected across the antenna feed point thereby preserving the original compromise SWR on 60-10 meters.

When +12 V is applied, the inductor is connected across the antenna feed point and inductor turns are shorted to resonate the antenna on 80 meters. In addition, part of the large coil is shorted out to resonate the antenna on 80 meters.

When the voltage is reversed, the short across the coil is removed and the matching section resonates the antenna on 160 meters. In both the 160 and 80 meter cases, the unun secondary taps into the inductor at the 200 Ω point, providing a proper match to the unun on these bands. This keeps the unun secondary voltage reasonable, and the feed line and unun losses very low as well.

I built the matching unit into an 8 × 8 × 4 inch NEMA weatherproof box available from home supply stores. This box is too small to fit the entire inductor length needed, so I split the inductor into two pieces as can be seen in Figure 1. The long inductor section consists of 61 turns, and the short
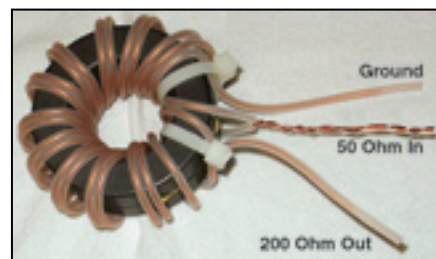


Figure 3 — Voltage unun connections (MFJ 10 10989D shown).



Figure 1 — The split inductor mounted in the NEMA enclosure. Alternatives are to use a larger box and keep the inductor intact or use the toroid wound inductor specified in Part 1.
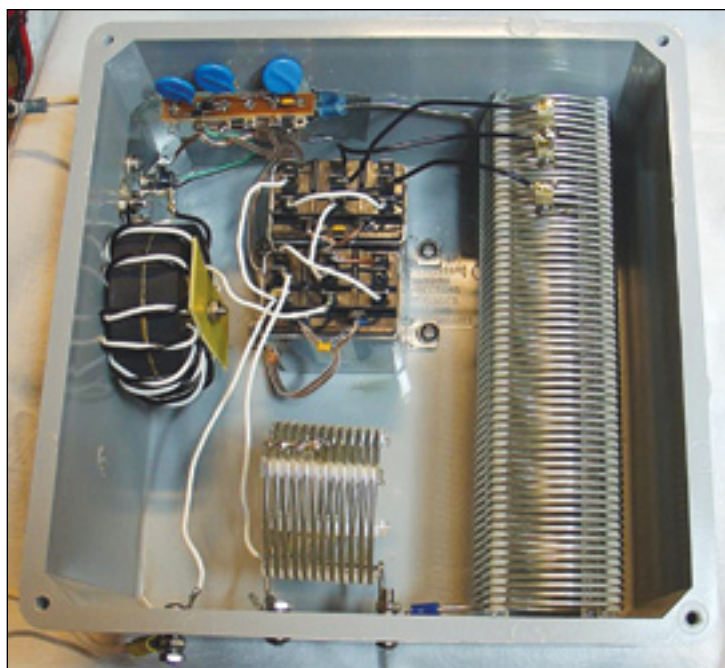


Figure 2 — All parts mounted in the NEMA enclosure.

inductor section consists of 12 turns. While I preferred the more compact size of this box, you may wish to use the larger 12 × 12 × 4 inch NEMA box that can contain the full uncut inductor length needed.

All internal wiring uses insulated #14 AWG stranded wire. I attached the wires to the coil tap points using the MFJ coil clips called out in the parts list. You can solder the wires directly to the coil, but this is difficult due to the #12 AWG size of the coil wire and the spacing of the turns. The coil is mounted with #8 stainless steel screws, washers, lock washers and nuts also used for the ground and antenna feed terminals. Table 1 lists the parts and part sources, and Figure 2 shows the final matching unit with all components mounted. Note the terminal strip with the MOVs and bypass capacitors.

Since the antenna is unbalanced, a current balun or voltage unun is typically used. A voltage unun should be wired as shown in Figure 3.

## Relay Connections

Some comments are necessary regarding the relay connections. See the sidebar for a discussion of how high the peak voltage across the full coil can be on 160 meters. As you can see, I connected relay contacts in series to increase the overall breakdown voltage. Also, the tap points on the inductor provide additional voltage above ground, which helps with the overall breakdown voltage.

The main concern is with the contact-to-coil 5.3 kV peak breakdown rating. When I examined the relays, I observed that the outer SPDT contacts are connected via insulated internal wires that are well separated from the coil by 0.1 to 0.2 inches. The problem is with the center SPDT relay common wire, which is in contact with the coil. While the coil and common wire are both insulated, there is no air-gap separation between them. This common wire-to-coil contact is obviously what determines the breakdown voltage rating. The way I got around this problem was to use the center SPDT relay contacts for the lowest potential interfaces as indicated in the schematic (Figure 4).

For the switched control voltage input, I used a 12 V, 1 A wall wart to keep the +12 V control voltages separate and isolated from the regular station voltage. This is to eliminate any possibility of shorting the main power supply when the control voltage polarity is flipped. The switching is easily done with a DPDT/center-off switch wired as shown in Figures 5 and 6.

I mounted the switch in a small plastic box that I attached to my transceiver support shelf as you can see in Figure 7. The unlabeled center-off position is for 60 through 10 meter operation. The separate switch you see in the photo is for controlling other outdoor accessories, as I have two voltage feeds going out to my antenna location.

## Matching Network Resonance

As with the previous matching network, you will almost certainly need to adjust the resonant frequency of the matching network due to variations in particular antenna physical construction, proximity to other objects and final length, as well as your desired operating frequency range. The overall starting inductance is too large for 160 meters, so the network will resonate at or below the lower
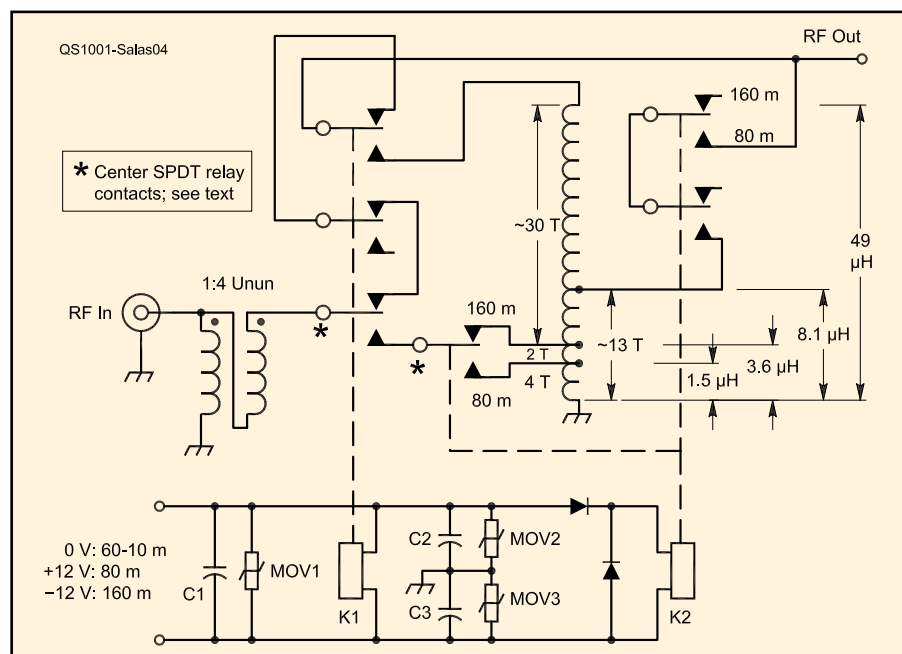


**Figure 4 — Schematic of the remotely controlled matching network. The parts are defined in Table 1.**

## Table 1

### Parts List for 160 and 80 Meter Impedance Matching Assembly with 1:4 Unun

| Description | Source/Part Number* |
|---|---|
| C1-C3 — 0.10 µF capacitor | Mouser 581-SR215C104KAR. |
| J1 — SO-239 UHF coax jack | MFJ-7721. |
| J2 — Jack, dc power, 2.1 × 5.5 mm | Mouser 163-1060 EX. |
| K1, K2 — Power Relay, 3PDT | Array Solutions RF-3PDT-15. |
| L1 — Inductor, 12 79 µH | MFJ 404-0669. |
| MOV1-MOV3 — MOV, 18 V dc | Mouser 576-V22ZA2P. |
| S1 — DPDT center-off switch | All Electronics MTS-12. |
| T1 — Unun, 1:4 ratio, 1.5 kW | MFJ 10 10989D. |
| T2 — 12 V, 1 A wall transformer | All Electronics DCTX-1218. |
| Coil Clips (2 required) | MFJ 755-4001. |
| Micro-gator clips (5 required) | Mouser 548-34. |
| NEMA box, 8 × 8 × 4" | Lowes/Home Depot. |
| Plastic box, 1.97 × 1.38 × 0.8" | All Electronics 1551-GBK. |
| Terminal strip, 6-lug | Mouser 158-1006. |
| Test clips, (5 required) | Mouser 13AC130. |

*All Electronics parts are available from **www.allelectronics.com**; Array Solutions parts are available from **www.arraysolutions.com**; MFJ parts are available from **www.mfjenterprises. com** and Mouser parts from **www.mouser.com**.
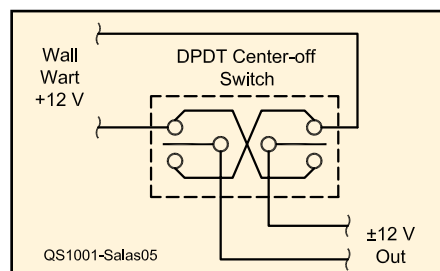


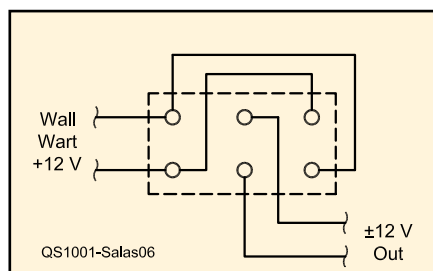**Figure 5 — Schematic of the dc switch contacts.**



**Figure 6 — Physical arrangement of the dc switch connections.**
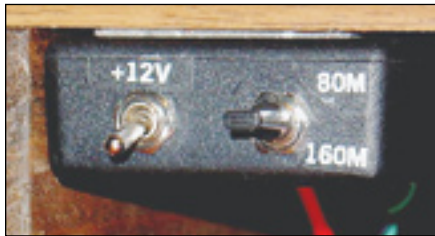
**Figure 7 — Switch control box mounted at operating position. The switch labeled +12 is for a different project.**
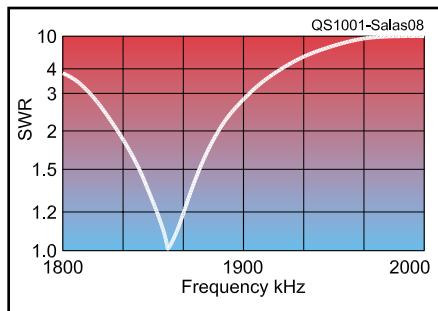


**Figure 8 — The measured 2:1 SWR bandwidth on 160 meters is about 50 kHz as shown.**
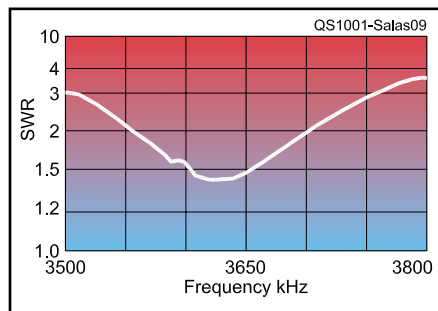


**Figure 9 — The 2:1 SWR bandwidth on 80 meters measured in at about 150 kHz.**

band edge. Therefore, you can simply short one or more of the upper (short coil) inductor turns in order to tune the network higher to your desired 160 meter frequency.

To do this, first leave off the wire leads that attach between the relay contacts and the tap points on the coil. Build up short jumpers using the test-clips and micro-clips (perfect for the coil turn taps) called out in the parts list, and attach these between the relay contacts and coil, using the suggested tap points shown on the schematic.

Connect the matching assembly to the base of your 43 foot vertical. Then enable 160 meter operation by applying −12 V dc, and jumper turns on the 12 turn inductor with a short clip lead until you find your desired 160 meter resonance point. Next, move the 160 meter relay tap point until you get minimum SWR. Now permanently short the turns on the short coil by soldering a piece of #16 AWG buss wire across these turns.

As you can see from my photos, I needed

to short six turns on this coil. Next enable 80 meter operation (apply +12 V to the relays assembly) and select the coil shorting point for your desired resonant frequency and the tap point for best SWR. Finally remove the test clips leads, attach the coil clips, and solder wires between the coil clips and relay.

My final results for 160 and 80 meters are shown in Figures 8 and 9 as measured with my RigExperts AA-200 connected directly at the matching network input at the base of the antenna. I'm a CW operator, so I favor resonance in the lower part of these bands. The 2:1 SWR bandwidth on 160 meters is about 50 kHz, and about 150 kHz on 80 meters. Even a 4:1 SWR on these bands results in negligible

SWR related cable and unun loss, and is easily matched with my MFJ-998, an in-shack tuner.

## Operation

Operation of this matching unit couldn't be simpler. When no control voltage is applied, the antenna functions as it always has on 60 through 10 meters. For 80 meter operation, apply +12 V dc, and for 160 meter operation apply −12 V dc. The matching unit connected to the base of my 43 foot vertical is shown in Figure 10.

## Conclusion

The matching network discussed in this article will permit very effective operation of

**Figure 10 — The completed all band remotely controlled switching and impedance matching network mounted at the antenna base.**

the less expensive RF-10 relays are all you will need. Have fun, and I'll see you on the low bands.

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your 43 foot vertical on all bands from 160 through 10 meters. Although on 10, 12 and 15 meters the elevation angle of the peak is higher than optimum for DX, it will still allow contacts. Feel free to experiment a little. You might prefer to use the toroid from Part 1 in this design instead of the air-core inductor. If you are not running more than about 500 W,